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VOL. CXXXIV.—No. 3481] LONDON: FRIDAY EVENING, SEPTEMBER 15, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of—

1. SHOVELS.
2. COCKS, BIB and STOP, GALVANISED.
3. POINT RODDING, 1¼in.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 6th October, 1922.

T. RYAN,
219 Director-General.

Ministry of Transport.
ROADS DEPARTMENT.

APPLICATIONS are INVITED for a limited number of TEMPORARY APPOINTMENTS as ASSISTANT ENGINEERS, at a salary of £350 per annum inclusive, in connection with road works in progress in Kent and Essex.

Candidates should be Associate Members of the Institution of Civil Engineers, or should hold the testamur of the Municipal and County Engineers' Institution, or some equivalent or higher professional qualification. Experience in road and bridge construction is essential. Candidates should not be more than 35 years of age, and only men who have served in His Majesty's Forces will be considered.

Forms of application can be obtained from the ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall-gardens, S.W. 1. Applications can only be received on the recognised forms, and should reach the Ministry of Transport on or before 26th instant. 265

Six Assistant Engineers
REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of 12 to 18 months, with possible extension. Salary £480 per annum, rising by annual increments of £30 to £720 per annum, and thence by annual increments of £40 to £920 per annum. Outfit allowance of £60 on first appointment. Free first-class passages and single quarters provided. Liberal leave in England on full salary after each tour.

Candidates, age between 22-35, preferably unmarried, must have had a good general education and (a) be A.M.I.C.E. or hold equivalent professional qualifications, or (b) have passed the full examination of the Institution of Municipal and County Engineers. They must have had proper technical training and have had not less than three years' subsequent experience on large engineering or municipal works, preferably including experience in waterworks construction and maintenance.

Apply at once, in writing, stating age and detailed qualifications, and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W., quoting M/11,605. 278

The University of Sheffield.
SESSION 1922-23.

Vice-Chancellor: Sir HENRY HADOW, C.B.E., M.A., D.Mus.

DEPARTMENTS of MECHANICAL, ELECTRICAL and CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY and GLASS TECHNOLOGY.

PROFESSORS.

Mechanical Engineering.—W. RIPPER, C.B., D.Eng., D.Sc., M. Inst. C.E.
Metallurgy.—C. H. DESCH, D.Sc., Ph.D., F.I.C.
Civil Engineering.—J. HUSBAND, F.R.C.Sc.I., M.Engr., Assoc. M. Inst. C.E.
Mining.—D. HAY, B.Sc., Assoc. M. Inst. C.E.
Fuel Technology.—R. V. WHEELER, D.Sc., F.I.C.
Glass Technology.—W. E. S. TURNER, O.B.E., D.Sc., F. Inst. P.
Chemistry.—W. P. WYNNE, D.Sc., F.R.S., F.I.C.
Physics.—S. R. MILNER, D.Sc., F.R.S., F. Inst. P.
Geology.—W. G. FEARNSIDES, M.A.

Electrical Engineering.—E. H. CRAPPER, M. Eng., M.I.E.E. (Lecturer).
Mathematics.—C. A. STEWART, M.A. (Lecturer).

The Courses in the DEPARTMENT of ENGINEERING extend over three or four years and prepare students to become Mechanical, Electrical, Civil, or Mining Engineers, or specialists in Fuel Technology, or Glass Technology.

The Courses in the DEPARTMENT of METALLURGY cover a period of three or four years and prepare students for positions of responsibility either (1) in Iron and Steel Manufacture, or (2) in the Non-ferrous Metallurgical Industries.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular courses.

In Mining Engineering, and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students, who come to the University from works or collieries, to take six months' courses of study at the University and six months' practice at the works or colliery each year for a period of four years.

The LECTURE COURSES commence OCTOBER 4th, 1922.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 26th, 1922.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas and Certificates awarded on their successful completion, application should be made to

9097 W. M. GIBBONS, Registrar.

Battersea Polytechnic, London, S.W. 11.

Principal: ROBERT H. PICKARD, D.Sc., F.R.S.

ENGINEERING DEPARTMENT.

EVENING CLASSES suitable for Final B.Sc (Eng.), A.M.I.C.E., A.M.I.M.E., &c., are held in the following SUBJECTS:—

Strength of Materials with Laboratory Testing.
Theory of Structures and Structural Design.
Theory of Machines and Machine Design.
Heat Engines with Laboratory Testing.
Hydraulics with Laboratory Testing.

Students enrolled from September 19th to 22nd.

DAY TECHNICAL COLLEGE.

FULL-TIME COURSES in Mechanical, Civil and Electrical Engineering for B.Sc. (Eng.) Degree, University of London, or College Diploma COMMENCE SEPTEMBER 25th. Entrance examination commences September 19th. Fee: £18 per session. A higher fee will be charged to students not residing in London.

Full particulars of all classes on application to the PRINCIPAL. 166

The Engineer

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Iron and Steel Institute at York—No. II.

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North-Eastern Passenger Electric Locomotive.

British Association at Hull.

Scientific and Industrial Research.

The Gennevilliers Electric Power Station (No. II).

Deflection Testing of Locomotive Axles.

PUBLIC NOTICES

UNIVERSITY OF LONDON.
King's College.

FACULTY OF ENGINEERING.

Complete COURSES of STUDY, extending over either three or four years, are arranged in

CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.

The four years' course provides, in addition to the academic training, opportunity for practical training in "works."

HEADS OF DEPARTMENTS.

Professor G. COOK, D.Sc., A.M. Inst. C.E., A.M.I. Mech. E., Mechanical Engineering.
Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering.
Professor E. WILSON, M. Inst. C.E., M.I.E.E. (Dean), Electrical Engineering.
Professor S. A. F. WHITE, M.A. }
Professor G. B. JEFFERY, M.A., D.Sc. } Mathematics.
Professor SAMUEL SMILES, O.B.E., D.Sc., F.I.C., F.R.S. }
Professor A. J. ALLMAND, M.C., D.Sc., F.I.C. } Chemistry.
Professor O. W. RICHARDSON, D.Sc., F.R.S., Physics.
Professor W. T. GORDON, D.Sc., F.R.S.E., Geology.

Considerable extensions have been made in the Engineering Department. These include a large additional drawing office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments; and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the laboratories in the three Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 3800

Technical College, Bradford.
DAY COURSES.

FULL-TIME (Day) COURSES, extending over three or four years, and leading to the Diploma of the College, are arranged in the following Departments:—

TEXTILE INDUSTRIES.
CHEMISTRY.
DYEING.
MECHANICAL ENGINEERING.
CIVIL ENGINEERING.
ELECTRICAL ENGINEERING.
BIOLOGY.

Special facilities are available for ADVANCED STUDY and RESEARCH.

Further particulars and prospectuses may be obtained on application to the PRINCIPAL, Technical College, Bradford. 263

Leeds Education Committee.
CENTRAL TECHNICAL SCHOOL.

PRINCIPAL: R. E. BARNETT, B.Sc.

LECTURER REQUIRED, to give three or four Lectures on "SMOKE ABATEMENT—TRAINING OF STOKERS," from the practical boiler-house standpoint.

Syllabus of subject matter supplied on request.

Applications, with full particulars, should be sent at once to the Principal.

JAMES GRAHAM,
Director of Education.
Education Offices, Leeds. 221

PUBLIC NOTICES

Borough Polytechnic Institute,
BOROUGH-ROAD, LONDON, S.E. 1.

REQUIRED, a LECTURER in PRACTICAL MATHEMATICS for Monday, Tuesday, and Friday evenings, 7 to 9.15, commencing 25th September. Remuneration at the rate of 15s. per evening, plus 10 per cent. provisional.

Applications should be addressed to the undersigned.

12.9.22. J. W. BISPHAM,
Principal.
250

Aberdeen Corporation Water-Works.
EXTENSIONS 1920.
CONTRACT No. 7.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the TRANSPORTING, LAYING and JOINTING of 2 MILES of 48in. MILD STEEL PIPING and ANCILLARY WORKS between Gateside of Inchmario and Banchory Railway Station.

The drawings may be inspected and specifications, schedule of quantities and forms of Tender obtained on and after 21st September, 1922, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen.

For each specification a deposit of Five Pounds Sterling in cash will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification, and schedule of quantities provided with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.

Tenders on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for New Aqueduct," and addressed to the undersigned, must be delivered not later than 11th October, 1922.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M. Inst. C.E.,
Water Engineer.

Water Engineer's Office,
41½, Union-street, Aberdeen,
12th September, 1922. 252

Borough of Reigate.
ELECTRICITY.

The Council of the said Borough invites TENDERS for HIGH-PRESSURE SWITCHGEAR in connection with its electricity undertaking.

Specifications can be obtained from the Consulting Engineer, Mr. C. H. Wordingham, C.B.E., M. Inst. C.E., 7, Victoria-street, London, S.W. 1.

Deposit, Three Guineas, returnable on receipt of bona fide Tender. Extra copies One Guinea each, not returnable. Cheques should be made payable to Mr. C. H. Wordingham.

Sealed Tenders, endorsed "Tender for Switchgear," addressed to the undersigned at the Municipal Buildings, Reigate, must be delivered not later than 10 a.m. on Thursday, the 28th September instant.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
ALFRED SMITH,
Town Clerk.
Municipal Buildings, Reigate,
12th September, 1922. 248

New South Wales, Australia.
SYDNEY HARBOUR BRIDGE.

Intending tenderers are hereby notified that the TIME for RECEIPT of TENDERS for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour has been EXTENDED by the New South Wales Government until 1st SEPTEMBER, 1923.

T. A. COGHLAN,
Agent-General for New South Wales.
Australia House, London, W.C. 2,
14th July, 1922. 3841

PUBLIC NOTICES

National Gas Council of Great Britain and Ireland.

GAS COOKING STOVES.

For the purpose of enabling Standard Cookers, manufactured according to specifications approved by the National Gas Council, to be purchased by the Gas Industry, the Council is prepared to receive TENDERS for the SUPPLY of the following:—

(1) ONE SET of LEAD MASTER PATTERNS for each of two sizes of stove, viz., No. 2 (unpacked) and No. 3 (packed), in accordance with drawings and specifications to be supplied by the Council.
(2) SETS of original CAST IRON PATTERNS for each size of stove.
(3) ONE SET of MASTER JIGS for each size of stove.
(4) 12 SPECIMEN COOKERS of each of the above sizes in accordance with drawings and specifications to be supplied by the Council.
(5) Complete BASE STANDS (two sizes, viz., 4in. and 24in. high) in accordance with drawings and specifications to be supplied by the Council.
(6) ONE SET of LEAD MASTER PATTERNS for each size of stand.
(7) SETS of CAST IRON PATTERNS for each size of stand.
(8) Complete PLATE RACKS (including Back Plate) in accordance with drawings to be supplied by the manufacturer and to the general specification of the Council.

NOTE.—To enable them to adjudicate between the different Tenders submitted, the Council reserve to themselves the right to require detailed working drawings of all the above patterns and jigs, if they think fit.

Firms willing and able to supply are invited to apply in writing as soon as possible, but in any event not later than the 4th October, 1922, to the undersigned, for the necessary drawings, specifications, forms of Tender and of contract conditions, which will be forwarded upon payment of a fee of £25, which fee will be returned in cases where a bona fide Tender is duly made.

The Council does not bind itself to accept the lowest or any Tender.

W. J. SMITH,
Secretary.

National Gas Council of Gt. Britain and Ireland,
30, Grosvenor-gardens, London, S.W. 1.
11th September, 1922. 216

TO COLLIERIES, ENGINEERS, BOROUGH ENGINEERS, CONTRACTORS, AND OTHERS.
BURNT RED ASHES.

Large Supplies of Burnt Red ASHES WANTED, from Refuse Destructors, Pits, Collieries, Furnaces, Factories, &c. &c. Shale is of NO use.

* Write, giving particulars of supply and send 1 lb. sample (not more), to Box 5120, C. D. Flint, Ltd., 76a, Chancery-lane, London, W.C. 2. 222

12th September, 1922.

The Sudan Government Railways
REQUIRE the SERVICES of a DISTRICT LOCOMOTIVE SUPERINTENDENT. Age 26/32, preferably single. Candidates should have been trained on British railway or in a locomotive builder's works, and should have good knowledge of the working of a locomotive department. A.M.I.C.E. degree desirable. Commencing salary £E480, rising to £E900 per annum eventually. Temporary war bonus. Strict medical examination.—Application by letter to CONSULTING MECHANICAL ENGINEER, Sudan Government Railways and Steamers, 5, Northumberland-avenue, W.C. 2. 251

TO RAILWAY WAGON BUILDERS AND OTHERS.

Tenders are Invited for the following PARTS:—

400 Sets Axle Guards	100 Sets of Brake Gear
200 Draw-bar Hooks	200 Safety Chain Hooks
400 Spindles, complete	400 Buffers, Plungers and Cases, complete
200 Spring Washers	400 Front Washers
200 Spring Shackles	400 Middle "
200 Pins, complete	400 Back "
400 do.	400 Sets Bearing Springs
200 Angle Pieces	1200 Buffer and Draw Screw Couplings, complete
200 Face-plates	400 Buffer Recoil Springs
200 Suspender Hooks	400 Safety Chain Springs
200 Safety Chain Link Ends	400 Axle-boxes, complete
	400 M.S. Face-plates
	400 Dust Shield Covers

Prices to be given in detail, and delivery time to be stated.

All the above parts must conform to the Indian Conference Association Specification for Standard Bogie and Four-wheeled Goods Vehicles, a copy of which, along with blue prints of each part, can be seen at the Offices of TURNER and CO., 45, St. Mary Axe, London, E.C. 3, to which address all Tenders are to be sent before September 22nd. 235

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PUBLIC NOTICES

Newport (Mon.) Corporation
WATERWORKS.
TALYBONT SCHEME.—CAST IRON PIPE LAYING, &c.
CONTRACT No. 4.

The Waterworks Committee invite TENDERS for the LAYING and JOINTING of about 28 MILES of CAST IRON PIPES, 25in. dia.; 5 MILES, 19in. dia.; and SHORT LENGTHS of other diameters; and the CONSTRUCTION of a SERVICE RESERVOIR, BRIDGES, VALVE HOUSES, and other WORKS incidental to the piping, all of which will be situated in the valley of the River Usk. Plans and drawings may be seen and specification obtained at the office of the Engineers, G. H. Hill and Sons (Westminster), 3, Victoria-street, Westminster, on payment of Five Pounds, which will be returned to the tenderer provided that he shall have sent in a bona fide Tender and shall not have withdrawn the same, and shall have returned the documents and drawings lent to him. The said sum will also be returned to any applicant who decides not to Tender, if the documents and drawings are returned within seven days of their issue to him. A limited number of sets of the drawings, uncoloured, excluding Ordnance maps, are available for lending to persons who have applied for the specification, and will be lent to such persons in priority of application on payment of the sum of Three Pounds, which sum will not be returned. Inspection of site, Wednesday, the 27th September. Sealed Tenders, endorsed "Talybont Scheme, Tender for Contract No. 4," and addressed to the undersigned, must be received by me not later than Saturday, the 21st October. The Committee do not bind themselves to accept the lowest or any Tender. The contractor will be required to pay trades union rates of wages and observe the recognised hours and rules of labour.

O. T. MORGAN,
Town Clerk.

Town Hall, Newport (Mon.),
14th September, 1922. 277

The Great Indian Peninsula
RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

No.		Fee for Specification.
1.	POINTS AND CROSSINGS	£1
2.	C.I. POT SLEEPERS	£1
3.	TIE BARS, GIBS, COTTERS, &c.	10s.
4.	STEEL FISH BOLTS, SPIKES, &c.	10s.
5.	FENCING MATERIALS	10s.
6.	FENCING WIRE STRAND	10s.
7.	PLATELAYERS' TOOLS	10s.
8.	DRESSED WAGON COVERS	£1
9.	METALS, &c.	10s.
10.	DRAW BRASS ANGLES, &c.	5s.
11.	CANVAS HOSE PIPES	2s. 6d.
12.	CARRIAGE FITTINGS	5s.
13.	STEEL SCREW COUPLINGS	£1
14.	STEEL DRAW-BARS FOR WAGONS	£1
15.	C.I. WATER PIPES, &c.	10s.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Points and Crossings," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 26th September, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 13th September, 1922. 271

Wycombe Rural District Council.
STOKENCHURCH WATER SUPPLY.
CONTRACT 2.
MAIN LAYING, &c.

TENDERS are INVITED by the above Council for the PROVISION and LAYING of 1320 YARDS of 3in. and 4in. CAST IRON PIPES and necessary VALVES, STAND POSTS, EXCAVATION, &c.

Specification, form of Tender, and other information may be obtained from the Consulting Engineers, Messrs. Lucas and Pyke, 39, Victoria-street, S.W. 1, on payment of a fee of £1, which will be returned on receipt of a bona fide Tender.

Tenders, endorsed "Stokenchurch Water Supply, Contract 2," should be addressed to the undersigned, in a sealed envelope, on or before Thursday, the 28th September, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

B. L. REYNOLDS,
Clerk to the Council.

High Wycombe, Bucks,
14th September, 1922. 262

Metropolitan Borough of Woolwich.
ELECTRICITY DEPARTMENT.
DISPOSAL OF ELECTRIC AND STEAM GENERATING PLANT AND OTHER ELECTRIC POWER STATION AUXILIARIES.

The Woolwich Borough Council invite TENDERS for the PURCHASE of STEAM ENGINES, DYNAMOS and ALTERNATORS, BOILERS, FEED PUMPS, BOSY WATER SOFTENER, FEED TANKS, AUXILIARY TANKS, WATER PUMPS, STEAM, FEED and WATER PIPING and other AUXILIARY PLANT now available for disposal, in Lots shown on schedules which may be obtained on application to the Borough Electrical Engineer, 44, Powis-street, Woolwich, S.E. 18.

The Tenders must be on forms supplied, and in strict accordance with the conditions stated.

The Council reserve the right to withhold any lot from sale and to accept any Tender.

Tenders to be sealed and endorsed "Tender for Purchase of Plant," and delivered to me at the Town Hall, Wellington-street, Woolwich, not later than 5 p.m. on Tuesday, the 19th September, 1922.

By Order,
ARTHUR B. BRYCESON,
198 Town Clerk.

Skegness Urban District Council.
WATER ENGINEER.

FIRST ENGINEER (married) REQUIRED by the Skegness U.D.C., to Take Charge of the Suction Gas Plant at the Pumping Station, Welton Waterworks, Burgh, Lincs. To be thoroughly experienced in this class of machinery and capable of executing any repairs. None but competent men need apply. Wages £3 (set) per week, together with house, garden, and lighting free. Age to be stated and to submit three testimonials of recent date. Canvassing will disqualify. Applications to be addressed to me, with envelope marked at the left-hand top corner "Water Engineer," and received not later than the 30th September instant.

W. FREARSON,
Clerk.

Council Offices, Skegness,
13th September, 1922. 264

SITUATIONS OPEN

WANTED AT ONCE, in Southern County, Experienced MANAGER for Small Foundry capable of expansion. Present output mainly sewer, road and proprietary castings. Must be used to repetition methods and good organiser; also prepared to start on three months' trial basis; initial salary £5 per week. Good prospects to right man.—Address, P6072, The Engineer Office. P6072 A

WANTED by Firm Near London, ASSISTANT in WORKS PLANNING DEPARTMENT, accustomed to laying out of operations in Automobile Manufacture and General Engineering. Preference given to member of F.M.B.S.—State full particulars, qualifications, salary required, and references to Box E, 788, c/o Dawson's, 121, Cannon-street, E.C. 4. 225 A

WANTED, First-class MACHINE SHOP INSPECTOR; used to Viewing and Examining the Larger Machine Parts of Electrical Machines; only high-grade men with experience in maintaining a high standard of machine shop practice need apply. State age, wages and experience.—Address, 206, The Engineer Office. 206 A

NEW
VERTICAL BORING & TURNING MILL
100" CAPACITY.
Single Pulley Drive.
FOR SALE AT SACRIFICE PRICE.
The last word in Machine Tool design.

MARTIN BROS. (MACHINERY), LTD.,
35, BRIDGE STREET,
MANCHESTER.
231 G

SITUATIONS OPEN (continued)

WANTED for Production Department, ENGINEER who has had wide experience. Must be capable of making date programmes for drawing-office information, material supplies and shop manufacture, and have the capacity for seeing that these dates are kept to meet contract obligations. It is requested that only men who have held responsible executive positions will reply. State experience, salary, age, &c.—Address, 239, The Engineer Office. 239 A

AN ENGINEERING FIRM REQUIRE the SERVICES of a well-educated trained ENGINEER, who has specialised in Steam Generation, to act as foreign selling representative.

Knowledge of French and German essential, additional languages strong recommendation, particularly Spanish or Italian.

Age between 25/30.

Address, giving full particulars of education, engineering training and experience, also state salary expected, 223, The Engineer Office. 223 A

ASSISTANT ENGINEER REQUIRED for a Group of Collieries. Must combine good organisation with technical ability and be able to efficiently control labour. Must be six o'clock man. Highest references essential. Early prospects to suitable man. Applications treated in strict confidence.—Address stating age, experience, salary required, 273, The Engineer Office. 273 A

ENGINEERING REPRESENTATIVE REQUIRED by old-established firm of Reinforced Concrete Specialists for Lancashire district. Applications are invited on either of the following bases:—(1) Whole-time appointment on salary, commission and expenses; (2) from firms already holding one or more first-class building trade agencies, on commission and expenses only. Write, giving full particulars of experience and qualifications.

Address, P6048, The Engineer Office. P6048 A

MANAGER, STEAM SALES DEPARTMENT, handling Boiler Feed Regulator, Feed and Donkey Pumps; experience and connection essential. —Full particulars and salary required to Steam Department, ASTER ENGINEERING CO., Ltd., Wembley. 165 A

WORKS MANAGER WANTED by Firm of Nut and Bolt Manufacturers in the Midlands; must have strong and determined personality, capable in the management and control of men, and able to maintain a high standard of efficiency in the economic production of high-class bolts and nuts (both black and bright). Apply by letter in first instance, stating age, experience, qualifications, and salary required.—Address, P6078, The Engineer Office. P6078 A

WANTED, a JUNIOR DRAUGHTSMAN for Detailing Constructional Steel Work at a works in London district. State age, experience and salary required.—Address, P6076, The Engineer Office. P6076 A

WANTED by a Locomotive Works Near Manchester, ONE Good LOCOMOTIVE DRAUGHTSMAN, accustomed to taking out weights for estimates.—Address in confidence, stating age, experience, and wages required, 224, The Engineer Office. 224 A

WANTED, DESIGNER and DRAUGHTSMAN, with experience in Steel Constructional Designing, also Elevating and Conveying of Minerals, Grain, &c. —Address, stating age, experience, and salary required, 242, The Engineer Office. 242 A

WANTED, JUNIOR DRAUGHTSMAN. State age, experience, and salary required.—Address, 241, The Engineer Office. 241 A

CHIEF DRAUGHTSMAN.—Messrs. BARBER, WALKER and CO., Ltd., beg to THANK APPLICANTS, and inform them that this POSITION has now been FILLED. 272 A

DRAUGHTSMAN REQUIRED, Jig and Tool, with close knowledge of machining times, operation lay-outs; some electric traction experience desirable, but work is chiefly mechanical.—Address, P6084, The Engineer Office. P6084 A

DRAUGHTSMAN REQUIRED, with First-class experience in Water-tube Boiler Design for all pressures and experience in Fuel Pulverisation.—Write, with full details of experience and salary required, to Box 759, Sells' Advertising Offices, Fleet-street, E.C. 4. 276 A

DRAUGHTSMAN (Senior) REQUIRED for Large Engineering Establishment, with wide experience in A.C. and D.C. Motors. Only efficient men should apply, giving particulars of experience, age, and salary required.—Address, 266, The Engineer Office. 266 A

DRAUGHTSMAN WANTED for Experimental Work; must have good knowledge of Theory and Practice of Internal Combustion Engines and Machinery generally. Investment will be considered as inducement to engagement.—Address, P6059, The Engineer Office. P6059 A

FIRM in West of England REQUIRES Competent DRAUGHTSMAN of at least 10 years' experience in the Design of Air Compressors, Winding Engines and similar Machinery.

Applications, which will be treated in confidence should state age, experience, qualifications, positions held, and salary required.

Address, 227, The Engineer Office. 227 A

RAILWAY CARRIAGE and WAGON DRAUGHTSMAN (first class) REQUIRED for North Midland district, to supervise juniors, check drawings, and requisition materials. State age, salary required, and experience.—Address, 246, The Engineer Office. 246 A

ASSISTANT FOREMAN REQUIRED for Constructional Steel Works; permanency to suitable man.—Address, stating age, experience, and salary required, P6083, The Engineer Office. P6083 A

FOUNDRY FOREMAN ASSISTANT.—WANTED, a smart, capable MOULDER, accustomed to moulding machine work, capable of working the machines and setting the jaces. State age, experience, and wage required.—Address 240, The Engineer Office. 240 A

SITUATIONS WANTED

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For continuation of Small Advertisements see page 3.

The Meuse Lock on the Meuse-Waal Canal.

By Dr. L. R. WENTHOLT, Engineer in Charge of the Construction of the Meuse-Waal Canal.

No. II.*

(6) COMPOSITION OF CONCRETE.

EXPERIENCE has shown that Portland cement contains too much lime (CaO). This surplus lime eventually effloresces on the surface and gives the walls an ugly aspect. It is possible, however, to make a chemical compound of the surplus of lime and silica (SiO_2) by adding pulverised tuff (trass) to the cement. This compound of lime and silica does not dissolve in water. The composition of trass is:—SiO_2, 56 per cent.; Al_2O_3, 17.5 per cent.; CaO, 2.7 per cent. The trass cement is composed of one part cement and one-half part trass. By adding trass to Portland cement the proportion between the main constituents, lime, alumina and silica, may be altered as desired. An additional advantage—in Holland, at any rate—of

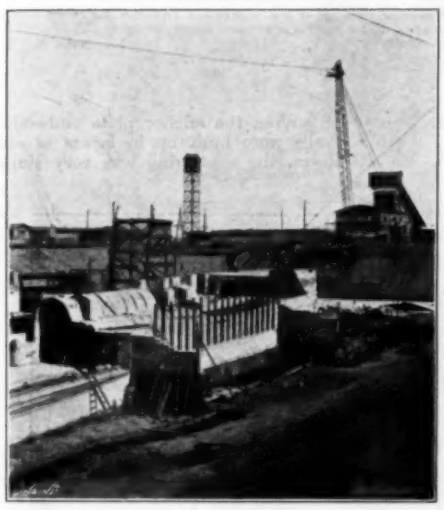


FIG. 16—HEAD SUPPORT AND OPERATING TOWER OF CABLEWAY

using trass cement instead of cement alone is that in that country the price of trass is only half that of the price of cement. The cement and trass are efficiently mixed in a Ransome "chemical mixer."

The material from the excavations for the foundations consisted of about 75 per cent. sand (to $^1/_4$in.) and 25 per cent. gravel (to about 2in.). The plain concrete was composed of 1 part trass cement, 6½ parts pit material, and 4½ parts gravel, which corresponds to 1 part cement, ½ part trass, $7^5/_{16}$ part sand and very small gravel (to $^1/_4$in.), and $9^9/_{16}$ parts gravel. The concrete for use with reinforcement consisted of 2½ parts trass cement, 6½ parts excavated material, and 4½ parts gravel. By providing the lock walls and the culverts with a protective covering of the very hard concrete blocks described in the previous article it was possible to build the mass of the walls of concrete with a very small percentage of cement.

(7) AERIAL CABLEWAYS.

There were more than 46,000 cubic yards of concrete and about 750 cubic yards of granite to be placed in the structure, and since it was intended to begin placing concrete in June, 1921, and to complete the structure before the winter of 1921-22, a period of only five months was available for carrying out this portion of the work. The handling plant, the construction plant and the shuttering were expected to be the determining elements in making progress in the placing of the concrete, and consequently they were studied most carefully. It was finally decided to lay the concrete and granite by means of aerial cableways. Before placing the order for the cableways the question of the type to be used was carefully considered. The cableways which have generally been used for work of this kind have been of the travelling type, having towers travelling lengthwise along the sides of the excavation, so that they worked transversely to the latter. The alternative was to use cableways having two slewing or luffing supports, so placed that one cableway commands the whole of one of the lock walls. It was considered that the latter, which may be termed "longitudinal cableways," were to be preferred for several reasons, viz.:—

(1) When using transverse cableways it is necessary to lay rather expensive tracks for the transport of materials, which are not required when longitudinal cableways are used.

(2) When transverse cableways are used it is necessary to pick up the materials at a different place every time the cableway moves, whereas longitudinal cableways always pick up their loads at the same point. The hauling of mixed concrete, granite and other materials to the cableways is, for that reason, much cheaper when longitudinal cableways are employed.

(3) With longitudinal cableways it is possible to convey materials at any moment to any part of the lock; this is of great importance for transporting granite and timber for shuttering.

(4) Travelling cableways arranged to operate transversely and their tracks occupy, as contrasted with longitudinal cableways, a great part of the site alongside the excavation pit.

(5) Longitudinal cableways are a little cheaper than transverse cableways, including their tracks.

The contract covering the design, manufacture and assistance during the erection of two cableways, with tipping skips and bogies for handling the concrete, was placed by the Dutch Government with John M. Henderson and Co., of Aberdeen, Scotland. The cableways have a clear span between the supports of 1570ft. and deal with individual loads of 4 tons. Each cableway is carried on two steel supports 105ft. and 92ft. respectively in height. They are arranged to give a lateral movement up to 13ft. on either side of their mean or upright position. This movement is accomplished by adjusting the wire rope stays which hold the supports laterally, by means of hand winches, and can be performed in the space of two minutes. Loads are hoisted at a speed of 245ft. per minute and made to travel longitudinally along the cable at the rate of about 740ft. per minute by means of an electrically driven winding gear specially arranged for cableway work. The electrical equipment of each winding gear comprises a reversible slow-speed motor of 100 brake horse-power with a tramway type controller and other accessories. The control of the operations of each cableway is performed by one man. In order that the operator should be afforded a good view of every point of the lock he is stationed on a platform erected at a height of 50ft. above the level of the ground near one end of the cableway. All the movements of a load are controlled from this platform. An automatic indicator showing the horizontal and vertical position of the load is provided at the operating platform.

The cableways have worked very satisfactorily and have fully come up to the expectations. It was possible to manœuvre them so accurately that the large blocks of granite, the auxiliary culverts, and the roofs of the main culverts could be put exactly in their places—see Fig. 13 *ante*. The head support and the operating tower of one of the cableways are shown in Fig. 16.

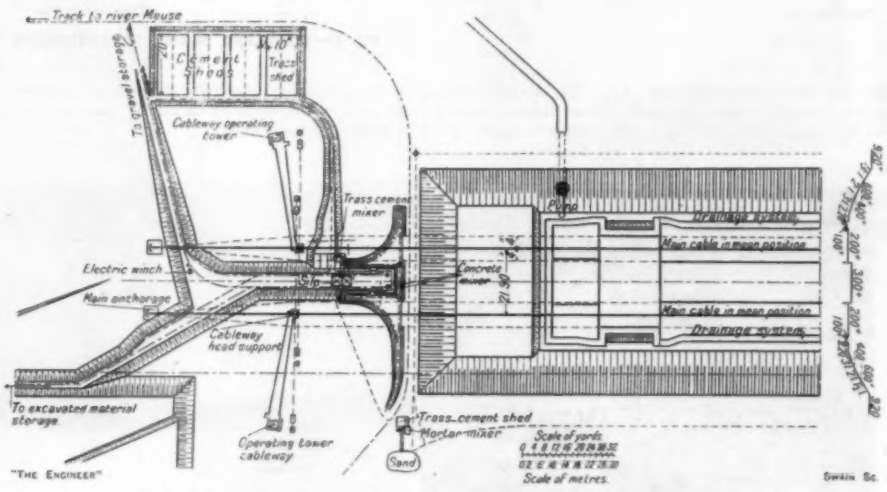


FIG. 17—ARRANGEMENT OF CONCRETE HANDLING PLANT

(8) CONCRETE HANDLING PLANT.

The concrete handling plant selected—see Figs. 17 and 18—was composed of the following elements:—(*a*) Cement and trass sheds, (*b*) track from cement and trass sheds to trass-cement mixer, (*c*) trass-cement mixer, (*d*) elevator from the mixer to the trass-cement silo, (*e*) tracks from the gravel and excavated material storage heaps to the concrete mixers, (*f*) electrical winch, (*g*) two concrete mixers, (*h*) tracks for transporting mixed concrete, (*i*) cableways, (*j*) concrete skips, and (*k*) dump cars. The mixers winch and elevator are operated electrically. The gravel was obtained by a ladder dredger provided with screens and pumps for washing the material from the river Meuse. The liability of low water in the Meuse and the consequent possibility of there being times of some months duration when navigation on that river would be impossible, and the desire to eliminate all chance of a scarcity of material, were factors which made it necessary to provide for a large

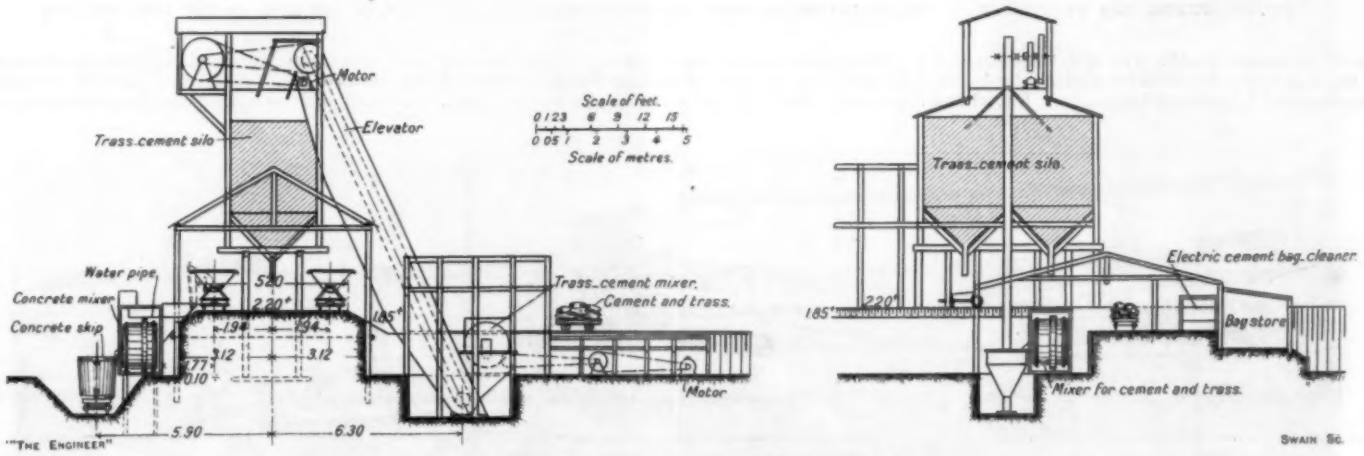


FIG. 18—ARRANGEMENT OF CONCRETE MIXING PLANT

* No. I. appeared September 8th.

storage of gravel. The gravel was transported from the river to the storage heaps by a steam-driven floating elevator and a temporary railway built principally for this purpose—see Fig. 25, page 263. From the storage heaps the material was taken to the mixers in dump cars, hauled up an inclined track by means of an electric winch. The material excavated from the foundation was also loaded into dump cars and transported by a benzol locomotive. Gravel and excavated material were discharged from the dump cars directly into the mixers—see Fig. 26, page 263.

Cement and trass were transported in bags on small flat cars along a track leading into the mixer building. The mixed trass and cement were elevated electrically into the trass-cement silo, from which they were taken to the concrete mixer by hand in barrows.

The disposition of the two stationary Ransome concrete mixers was such as to admit the substitution of one mixer for the other.

The mixed concrete was delivered in skips on small flat cars (bogies), which were hauled to the cableways by hand. Each skip had a capacity of 2 cubic yards. The average rate per hour was 40 cubic yards of concrete.

(9) SHUTTERING.

All the shuttering was of wood. The different kinds of shuttering used are shown in detail in Fig. 19. The panels were fixed by inclined struts or bolted to the concrete with anchor bolts 3ft. 4in. long, which were removed, leaving the anchor plate embedded. As the lock walls were built up in layers of only 3ft. 4in. thickness, the shuttering was very simple and inexpensive. Where the concrete blocks were used, shuttering was not required. The main culverts, too, were built without making use of any shuttering, except at both ends, where rather intricate forms were wanted—see Fig. 20.

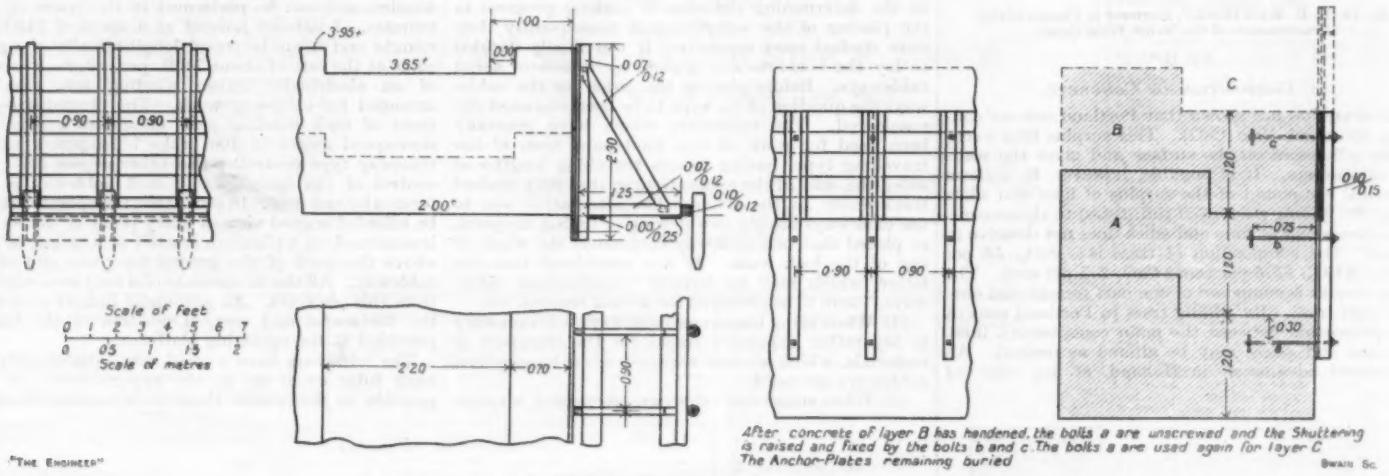


FIG. 19—DIFFERENT FORMS OF SHUTTERING

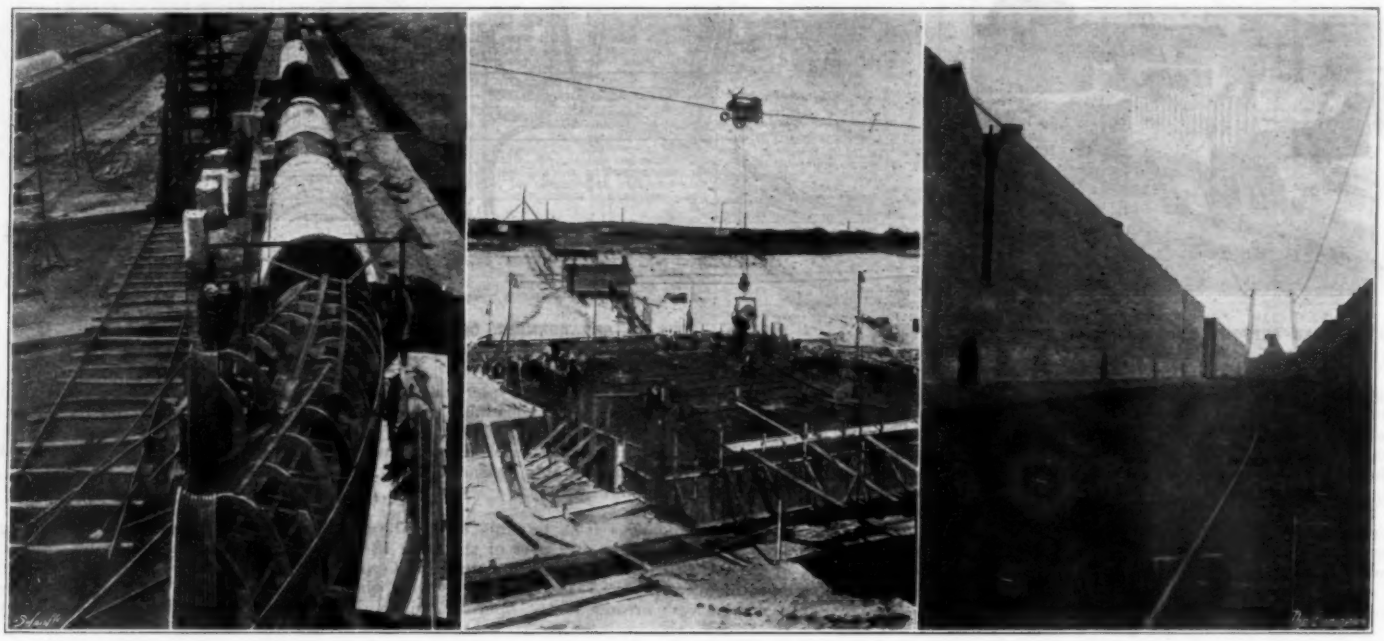


FIG. 20—BUILDING END OF CULVERT FIG. 21—PLACING CONCRETE FOR FLOOR UNDER LOCK GATE FIG. 22—THE WALL OF THE LOCK, NOV., 1921

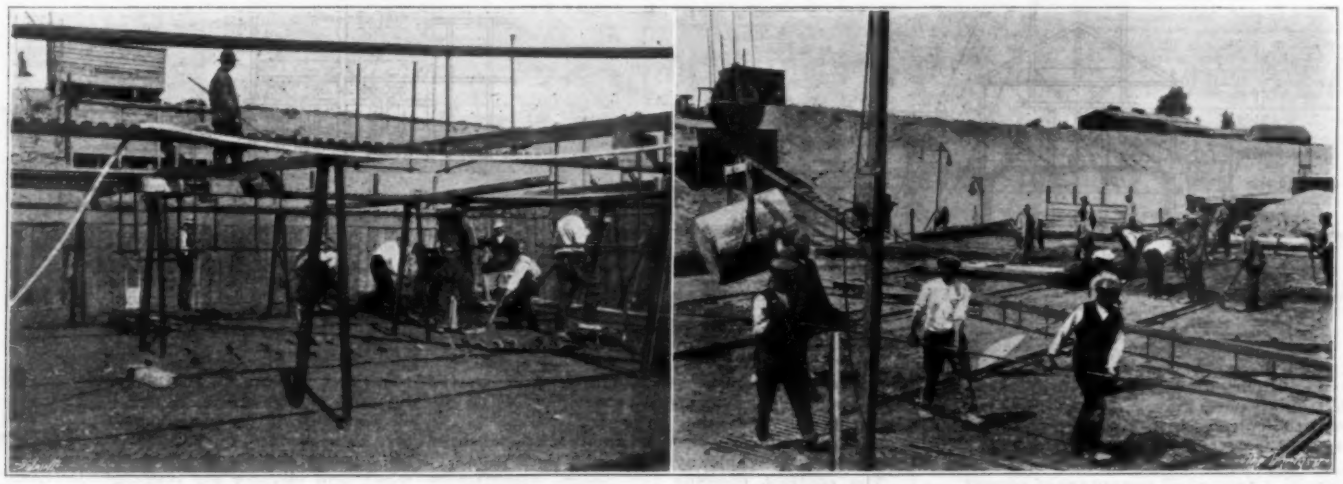


FIG. 23—STEEL TRESTLES FOR PLACING REINFORCEMENT FIG. 24—PLACING REINFORCING BARS IN FOUNDATION

(10) REINFORCED CONCRETE.

The only parts of the lock that are built of reinforced

THE MEUSE-WAAL CANAL

DR. L. R. WENTHOLT, NIJMEGEN, ENGINEER

FIG. 25—FLOATING ELEVATOR FOR TRANSPORTING GRAVEL

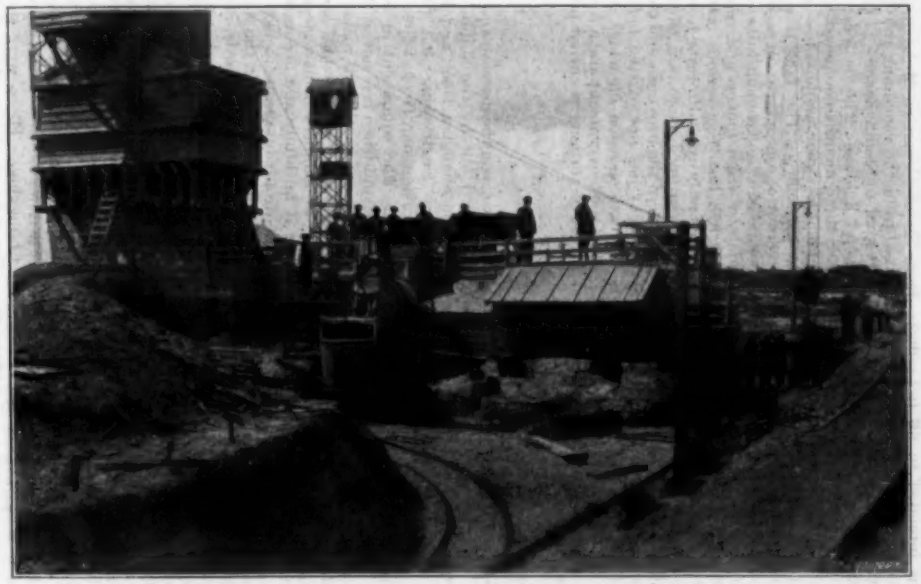


FIG. 26—TRASS-CEMENT SILOS, CONCRETE MIXERS, AND SKIPS

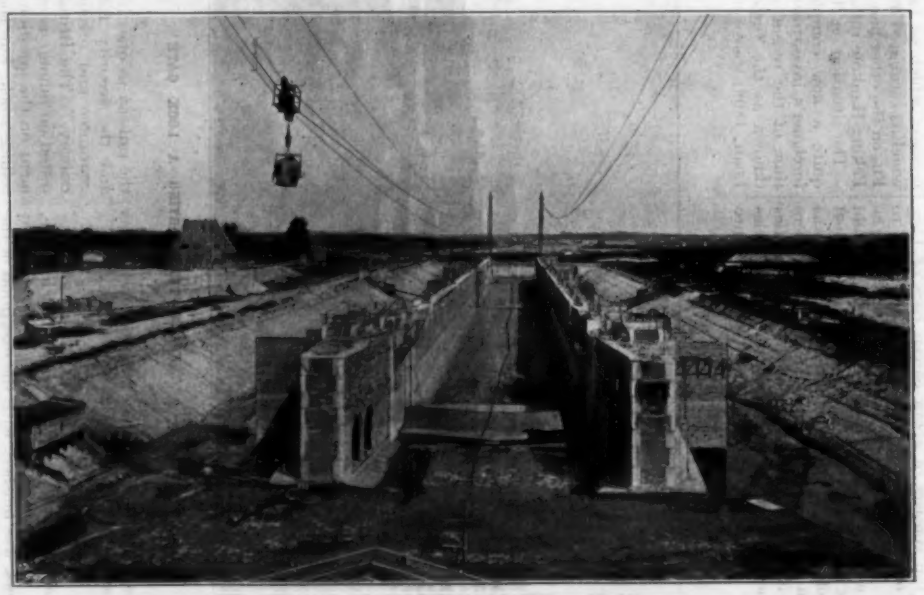


FIG. 27—THE MEUSE LOCK ALMOST FINISHED

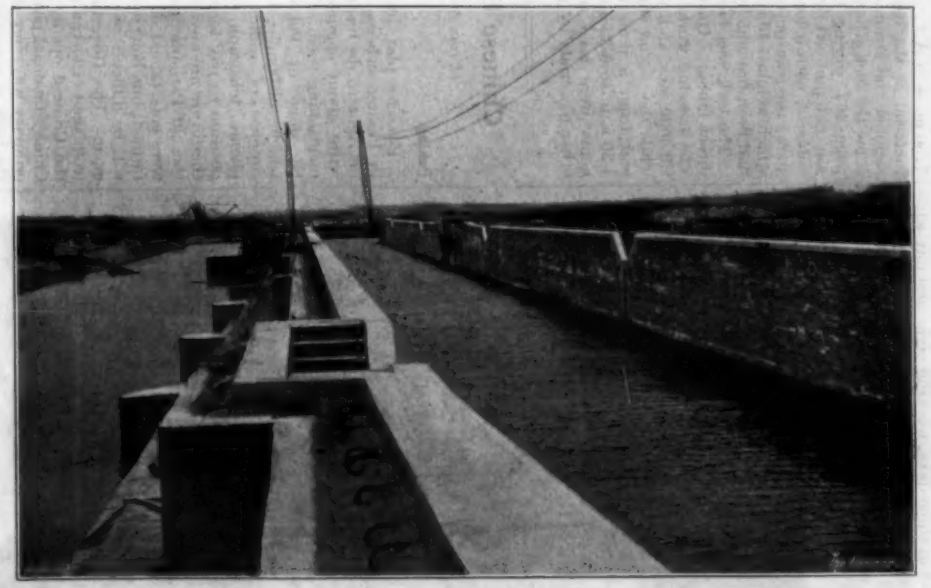


FIG. 28—THE MEUSE LOCK DURING THE WINTER 1921-2

concrete are the floors underneath the gates, which were laid in layers and measure 99ft. by 22ft. by 7ft. 6in., so that each contained a little more than 1800 cubic yards of concrete—see Fig. 21—which was placed in three days, working night and day with the two cableways. Two layers of iron bars were placed in the concrete, one near the bottom—see Fig. 23—and one near the top—see Fig. 24. That

FIG. 29—VIEW ALONG A MAIN CULVERT

near the top consists of about eleven bars of 1¼in. diameter and in lengths varying from 46ft. 6in. to 70ft. 6in. To make it possible to place and ram the concrete, which was mixed rather dry, the bars could not be put in position before the concrete had reached the level of the bars. To be sure that every bar was exactly in the desired position steel trestles were erected before the concrete was placed. These trestles were connected by tees, in which semi-circular holes were cut. The 250 reinforcing bars were placed into these holes in a little more than an hour, and it was not necessary to stop placing the concrete.

(11) GENERAL.

The placing of the concrete was started in June, 1921, and was finished November, 1921. By that time the lock was finished, with the exception of the top of the walls near the gates, where the machinery is to be placed. Those parts could not be completed in 1921, as at that time no decision as to the design of the operating machinery had been reached. They were, however, finished in the spring of this year. During the past winter pumping was stopped and the water rose in the excavation till it reached a level of 7.50 m. + N.A.P. (K.P.). It is intended to fill in material at the backs of the lock walls during this summer and autumn. Fig. 22 and Fig. 27, page 263, show the lock when it was almost finished; Fig. 28, page 263, during the winter, when the excavation was not pumped dry; and Fig. 25 one of the main culverts, with a length of about 330 yards. Fig. 30 shows the transportation of one of the steel lock gates, which weighed 40 tons, from the river Meuse, where it had been brought by ship, to the lock.

The lock was built by the Dutch Government by direct labour. During 1921 two shifts were worked. The first shift worked six days per week from 5.30 a.m. till 9.30 a.m. and again from 10.30 a.m. till 2 p.m.; while the second shift worked from 3 p.m. till 7 p.m. and from 8 p.m. till 11.30 p.m. The time from 4.30 a.m. to 5.30 a.m. and that between the working hours were used to transport granite, timber and other materials by means of the cableways.

FIG. 30—TRANSPORTING A LOCK GATE

Chinese Engineering Notes.

(From our own Correspondents.)

Peking.

POLITICS play such an important part in business in Peking—where, by the way, we foreigners have no right to do business at all—that it is difficult to write about engineering and other business without mentioning them. The only engineering business to be done in Peking is with the Government, which, although it is in urgent need of large supplies of rolling stock, rails, steel, tools, telephones, telegraph equipment, &c. &c., is not in a position to pay for such supplies. The prospects for the future are anything but hopeful. On August 1st, the old Parliament was due to reassemble, and hopes were entertained of a representative Cabinet being formed, but however good such a Cabinet may be, it will be difficult to carry on without financial assistance. The Government can obtain financial relief from the Consortium, but on the latter's terms, which the Chinese openly state they will never agree to. China's financial position would be bad enough in the ordinary way, but the position now is aggravated by the huge expenditure of the recent war and the fact that the Central Government is getting no revenue from the two best paying railways in China, viz., Peking - Mukden and Peking - Hankow Railways. Seventy-five per cent. of the rolling stock of the former line is still in the hands of the so-called Mukden War Lord, General Chang Tso Lin, who is retaining it outside the Great Wall, and practically running his own railway from Shanhaikwan to Mukden, the proceeds of which go towards the upkeep of his army, which is estimated at 200,000 men. General Wu Pei Fu, on the other hand, retains a large quantity of the Peking-Hankow rolling stock.

The situation on the Peking-Mukden Railway puts quite a new complexion on the question of the foreigner's investments in this country. Up to the time of the recent war the Peking-Mukden Bonds (known as the Imperial Railways of North China Loan, 1898) were considered a sound investment, as the railway in question is under British management and the security for the bonds is "Government guarantee and revenue of and mortgage upon the railway." The British Legation at Peking has protested on numerous occasions to the Central Government on the question of General Chang retaining the rolling stock, but the Government can do nothing. General Chang has got the rolling stock, and will disgorge it at his leisure. He is in a very strong position financially, and from a military point of view is probably better off than he was before he was defeated by General Wu Pei Fu. The result of this rolling stock being held up, and the fact that General Chang is withholding all the revenue of the railway from Shanhaikwan to Mukden, is that the revenue derived from the remaining part of the railway—from Peking to Shanhaikwan—is not sufficient to pay the bond holders. The decrease in revenue during the last three months compared to the corresponding period of last year amounts to over 5,000,000 dols. (Chinese currency). The fact that a Chinese general or governor of a province can seize the rolling stock and revenue of a Government railway which has been financed by foreign money and represents the security for such a loan is a serious matter for the future of China's railways. Protests from a foreign Legation are useless until there is a Government in China that can govern the provinces and their officials. Such a Government has not existed here for years, but this is the first occasion on which a provincial official has defied the Government and a foreign Power and seized property forming security for a foreign loan.

Shanghai.

Local shipbuilding is on the increase and flourishing, and the work turned out by the shipbuilding companies, such as the Shanghai Dock and Engineering Company, the New Engineering and Shipbuilding Company, and the Kiangnan Dock, is just as good as the home product. The equipment in most of the yards is up to date, and when it is not so the patience and skill of the Chinese mechanics make up for the lack of tools, as once these mechanics know how to turn out a piece of machinery or fit a stern post they will go on doing it faithfully and accurately in spite of what would be disadvantageous to us.

There is room for improvement in the way of equipment in some of the shipbuilding yards, and suppliers of modern machinery for such work would find it worth while to study the conditions and offer equipment which would increase the efficiency of the local yards. Most of the building work done at the yards is on coasting steamers up to 3000 tons, river steamers of somewhat different type but of smaller tonnage, and high-powered steamers up to 2000 tons for service on the Upper Yangtsze between Ichang and Chungking and beyond into the confines of Szechwan province. There are now sixteen steamers plying between Ichang and Chungking. There were none twenty years ago. The 400-mile voyage through the mighty gorges and rapids has to be experienced to be believed possible. There are steamers now trading beyond Chungking right up to Suifu, 1400 miles from the sea. The Yangtsze with its tributaries and adjoining shallow lakes affords opportunities for special designing, and there are many fine examples plying on these waters. Steam is still the prime mover in the larger vessels, but paraffin and crude oil engines are used in many of the smaller craft and are giving satisfaction. The demand for small launches with petrol or paraffin engines must go on increasing, as the field for this type and the powered houseboat is huge with the thousands of miles of navigable creeks in the vicinity of Shanghai and other ports on the Yangtsze. I see these small craft at many of the ancient inland cities with the Chinese owner and his wife taking an airing; the launches are also being used as ferries from office to factory.

The scope for such small craft can be better realised when it is seen that the waterways are still the highways of the Yangtsze Valley, and cities like Soochow resemble Venice in that the citizens get about over the sixteen square miles of the city by water transport, and although at present the banks of the waterways and the waterways are crowded with the slow-moving junks and sampans of the fashion of centuries ago, the powered craft is beginning to disturb the peace of the scene whilst bringing a profit to enlightened owners. To see a smart motor launch entering the city under the 30ft. high watergate arch through the 12-mile long wall rubbing the ancient and rickety gate as it reluctantly opens to admit the highly efficient innovation is a picture representing the vast bulk of China being edged into Western notions. Powered trawlers are wanted for use in the fishing industry of China, which is in need of enterprise, as at present this industry is falling off, China now importing fish from Hong Kong and Japan. Three 10,000-ton freighters were built at Kiangnan Yard, Shanghai, for the United States Shipping Board, and these three vessels are among the best of their class and have been purchased by the Robert Dollar Company. The great home firms of Yarrow and Thornycroft have sent out shallow-draught vessels, knocked down, and after re-assembling here these ships are meeting with the success which the reputation of their designers and builders has always merited, and as these vessels were put together by local yards here and in Hong Kong, the home and local experiences are being combined to the advantage of British trade in China.

Hong Kong.

The largest vessel ever built in China or in Hong Kong was launched recently at the Taikoo Dockyard. The harbour master, Commander Beckwith, took the opportunity to announce that although 1921 was a bad year for trade and shipping all over the world,

yet in that year Hong Kong launched 14,000 tons more than all the other Colonies and Dominions (including Australia) put together. This statement will enable British engineering and shipbuilding firms to realise that Hong Kong is the most important of the oversea Dominions or Colonies as regards shipbuilding. It is true that "the biggest yet" from Hong Kong is not a very huge vessel, for the deadweight carrying capacity will be about 10,000 tons. The propelling machinery was sent out from Great Britain. There can be no doubt as to the ability of the Chinese mechanic, under foreign supervision, but there is also no doubt that without such supervision the work is not too reliable. With a single exception, there has been no example of successful co-operation among the Chinese in a large industrial establishment; and it seems certain that in the immediate future the industrial development of China must come through the initiative of foreigners. The success of the local shipbuilding firms suggests that Hong Kong is a very suitable place for pioneer industrial establishments in China.

The following particulars of the biggest ship yet launched in Hong Kong, namely, the Blue Funnel steamship Rhexenor, will be of interest. The principal dimensions are:—Length overall, 477ft. 6in.; breadth overall, 58ft. 4in., and 35ft. 3in. depth to upper deck from bottom of keel, the total gross tonnage being 8040, and the deadweight carrying capacity about ten thousand tons. The Rhexenor has two complete decks, with an orlop deck forward, poop, bridge and forecastle and citadel deck-houses at fore end of bridge, two pole masts, ten derrick poles, and six cargo hatches. The vessel has a raking stem and an elliptical stern, and has a cellular double bottom, the wings of which have been carried well up the sides of the vessel. Eight water-tight bulkheads are carried to the upper deck, giving the vessel six cargo holds. The space under the forecastle has been fitted up for emigrants, while the space under the poop is to be utilised for the accommodation of sailors and firemen. Petty officers' rooms are on the bridge deck alongside the engine casing. In the citadel house at the fore end of the bridge deck, the saloon, engineers' rooms, and three state rooms have been arranged, and on the deck over the saloon is a steel house containing the captain's day and night cabins, and four rooms for officers. Over this house again is the navigating bridge with wheel house and chart room. The vessel is supplied with eighteen steam winches and derricks carrying loads varying from 2 tons to 40 tons. A powerful Marconi wireless apparatus is installed with suitable rooms for the operators. The machinery consists of one set of Parsons' latest turbines driving through double-reduction gearing and capable of developing a total shaft horse-power of 6500. Steam is supplied to the turbines by two large double-ended boilers; one single-ended auxiliary boiler is also provided, and all the boilers have a working pressure of 220 lb. Electric light has been fitted throughout the ship. When completed and on service the Rhexenor will attain a speed of 14 knots. It is also right to add that just at present the local shipbuilding yards have several unoccupied slips, and no doubt they will appreciate a revival in shipbuilding. They have, however, always a great deal of repair work in hand, and there is always considerable activity in local shipyards. During the last three or four years some millions of dollars have been spent on extensions. The Hong Kong and Whampoa Dock Company has a large new dry dock in contemplation.

PLANS are being prepared for the construction of a pipe line by the Royal Dutch Shell interests from the oilfields of the General Asphalt Company in the Mene Grande area on the eastern shore of Lake Maracaibo, in Venezuela, to the ocean. The work has been expedited owing to a threatened shortage of fuel oil resulting from decreased production in the Mexican fields. It is estimated that the pipe line will cost not more than 1,000,000 dols.

Iron and Steel Institute.

No. II.*

MEMBERS reassembled in the hall of the Yorkshire Philosophical Society on the morning of September 6th for the last of the sessions of the York conference. Three papers were on the agenda for reading and discussion, but only the first of them attracted much attention, the absence of two of the authors being, no doubt, the main cause of the meagre discussion their contributions to the proceedings evoked.

In the first of the papers Mr. T. H. S. Dickenson gave an account of experiments on the flow of steel at a low red heat, with a note on the scaling of heated steels. A brief abstract of this paper follows.

FLOW OF STEEL AT RED HEAT.

Investigation of the mechanical properties of steels and alloys in the heated state has become a matter of very direct practical consequence, and has for some time past received much attention in the research laboratories of Vickers Limited, chiefly in relation to definitely stated conditions of service. As some of the results of this work appear to be of general interest, they are communicated to the Institute in the present note. All the steels which the author has investigated behave very much like highly viscous fluids at temperatures well below the critical range, and cannot be said to have any definite strength at a red heat. Thus statements, actually made, in more or less official reports, to the effect that (*a*) a high-speed steel has a tensile strength of 20.1 tons per square inch at 650 deg. Cent., or that (*b*) a 0.38 per cent. carbon steel has a tensile strength of 39,950 lb. per square inch at 550 deg. Cent., are not only meaningless, but may be misleading. Either steel would stretch continuously and finally break, under much less load, if given time. It is shown how very far from the truth the above figures actually are. The property of principal importance to the engineer who wishes to subject highly heated steel to stress is the equivalent of the viscosity of a fluid.

For the solution of a problem of immediate practical importance the author was content to ascertain, for each of a selection of steels, that temperature at which the rate of flow does not exceed a very small and practically negligible amount, under a uniform stress of 8.5 tons per square inch. A description of these experiments occupies the first half of the paper, whilst the second part is devoted to a discussion of some of the curves obtained.

Diagram 1 gives means of comparing accurately the results of tests varying in duration between six seconds and many thousands of hours, and Diagram 2 well brings out the enormous influence of time in determining the temperature up to which each type of steel can support a given load—in this case 8½ tons per square inch—and, by implication, the load which can be borne at any given temperature. It is easy to deduce, for example, that the maximum temperature up to which each of the typical steels will support a load of 8.5 tons varies, according to the conditions of loading, between the following figures:—

	Under a rapidly applied load, or for short duration of loading.	When the specimen is expected to endure for considerable periods without suffering sensible deformation.
	Deg. Cent.	Deg. Cent.
0.30 per cent. carbon steel	775	500
Nickel-chromium steel ..	805	450
High-chromium steel ..	800	520
High-speed steel	955	575
Nickel-chromium alloy	965	600

It is largely because results of the type set out in column 1 are those usually published, while working conditions demand the data of column 2, that the author ventures to present this communication, the intention being rather to call renewed attention to the decidedly misleading character of the term "tensile strength," as applied to steel at elevated temperatures, and to throw doubt upon the figures quite commonly accepted as representing this doubtful property, than to present a mass of data.

Opening the discussion, Mr. H. Brearley said there could be no doubt in the minds of those who had studied the paper that those responsible for the work had exhibited unlimited patience. The results set out added to the knowledge of the properties of steels at high temperatures. He thought the authors had been rather hard on those people who had given attention to the subject of tensile tests in saying that the information they had published was not only meaningless in many cases, but might be misleading. One thing in the paper with which he had been much impressed was the form of the stress strain diagram of material taken at very high temperatures. The material to which this test was originally applied was wrought iron, and in the case of that material it meant something which it could not mean when applied to steel. The main object of the author was to focus attention on the behaviour of structural parts at high temperatures, but to most of the members the interest was rather in the relative ease or difficulty with which the material could be deformed under rolls or hammers. In this connection he desired to draw attention to a number of tests which could be made quite simply, but of which the explanation was difficult. If one took a ¼in. bar of steel, heated it up to 1000 deg. or 1100 deg. Cent. at one end and to 600 deg. at the other end, and twisted it, the natural expectation would be that the greatest amount of twist would be obtained where the bar was hottest. That was not the case; it took the maximum twist at a point midway between the hotter and the cooler ends. He would like an explanation of that fact. He produced some of the bars for the inspection of members.

Mr. J. H. Whiteley referred to the second part of the paper dealing with the scaling of heated steels. He had noted the statement that in order to maintain through a period of one hundred hours a practically uniform rate of oxidation the heating was carried out under special conditions, but that the rate of oxidation was slowed down as adhering scale increased in thickness. He would like the author to inform the meeting on what grounds he made that statement. The rate of scaling was dependent on the rate at which oxidation could penetrate through the scale and reach the metallic surface underneath. If the rate at which the oxidation could penetrate to the metal below was quicker than the rate of reaction, then the rate of scale formation would remain uniform. If that were so it would explain Fig. 19 of the paper dealing with the rate of scaling. It was a point which ought to be cleared up.

Mr. Dickenson, in his reply, said there was room for much further investigation of the subjects raised in his paper. Mr. Brearley had suggested that he had been hard on those who had carried out tensile tests under conditions of rapid loading; but the point was that, not only in manufacturers' pamphlets, but in more or less official publications, figures derived from tests of that character were published broadcast. Such figures were valueless to a designer. The diagram on page 25 of the paper showed that with variations in loading conditions and time and temperature quite different results were obtained. With regard to the stress strain diagram, he realised that the behaviour of the material under rolls or hammers was of great interest to manufacturers. The experiments made by Mr. Brearley on the twisting of bars were also interesting, and he agreed that the results obtained did not fit in with his own work. He proposed to repeat those experiments. Mr. Whiteley had questioned the statement as to the slowing down of the rate of oxidation, but he could confirm the correctness of that assertion.

In the absence of the author Mr. G. C. Lloyd (secretary) read an abstract of the paper by Mr. H. K. Ogilvie, "Practical Notes on the Manufacture and Treatment of High-speed Steel." We reprint this paper practically in full elsewhere in this issue.

Mr. C. G. Carlisle thought the author had fallen into an error in laying down a rule that in any case the length of a heat should not exceed 4½ hours for a 3 or 4-ton furnace. There were many considerations which might prevent such a limit being observed. The author referred to the gas trouble; all electric furnacemen had passed through that stage and realised that it was the most difficult thing with which they had to contend, but it was capable of fairly simple explanation. The conditions under which Mr. Ogilvie worked were not so perfect as he had imagined, and there were two obvious reasons in his case for the gas trouble. One was over-oxidation of the bath; the other was

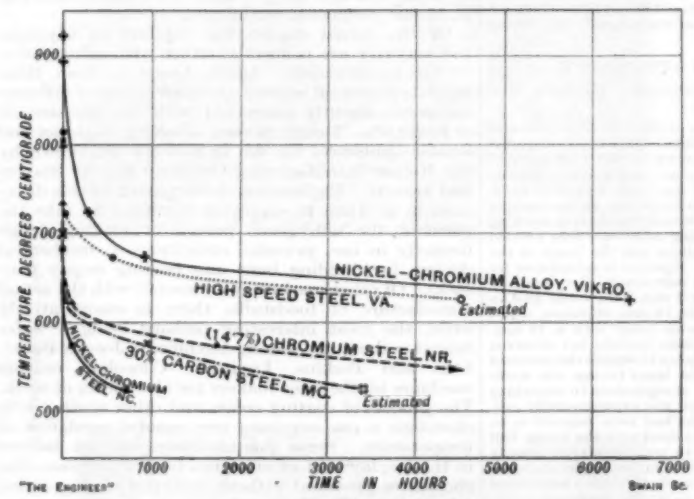


DIAGRAM 1

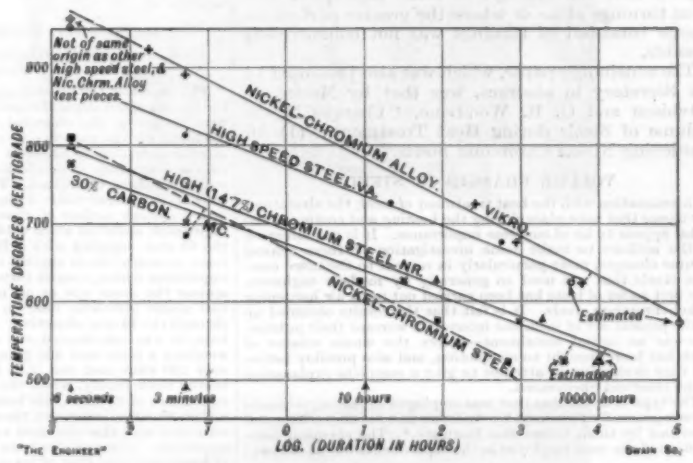


DIAGRAM 2

* No. I. appeared September 8th.

that sufficient fusibility of the slag had not been obtained at an early stage. If the slag had too much lime the direct are played on the bare metal and the metal was overheated. The author's method of cooling had to be adopted on occasions and was nearly always successful. He was rather surprised to notice that Mr. Ogilvie did not anneal his billet, and trouble might arise from that omission. The trouble was made worse rather than better by grinding. He noted, too, that the author neglected to anneal or temper his machine tools before hardening.

Mr. Brearley congratulated the author on the manner in which he had dealt with a difficult subject, but thought that some of his conclusions were open to doubt. Much interest had been aroused by the efforts of Coventry to make tool steel against Sheffield, and those engaged in the task had done very well. It used to be thought that the only way to put tungsten into high-speed steel was to use tungsten powder, but a young man had arisen in Coventry to tell them that ferro-tungsten was the right material to employ. The author raised a most interesting point in his statement that a low tungsten steel with a Brinell hardness number of 650 could be filed quite easily when hardened in oil from 1000 deg. Cent., but when hardened from 1300 deg. Cent. and having a hardness number of 550 it was impossible to file it. This example indicated the risk of accepting the Brinell test without qualifications. He was sure that members of the Institute would like to obtain specimens of these steels for the purpose of experiment.

Mr. V. Stobie referred to the statement in the paper that even when using clean turnings in the electric furnace there was a loss of 10 per cent. He personally thought the figure should not be higher than 5 per cent. Probably Mr. Ogilvie had not obtained the best metallurgical conditions in his furnace, as he referred to the removal of the vanadium by the time the metal was melted. That need not occur under proper furnace conditions. He could not agree with Mr. Ogilvie that the attempt to make high-speed steel from turnings alone or where the greater part of the charge consisted of turnings was not commercially possible.

The concluding paper, which was also presented by the Secretary in abstract, was that by Messrs. L. Aitchison and G. R. Woodvine, "Changes in the Volume of Steels during Heat Treatment: (1) Air Hardening Nickel Chromium Steels."

VOLUME CHANGES IN STEEL.

In connection with the heat treatment of steel, the alterations of volume that take place during the heating and cooling of the metal appear to be of supreme importance. It is the intention of the authors to make some investigation of these critical volume changes, more particularly in respect to the more complex steels that are used so generally by modern engineers. The first series of tests has been carried out upon air hardening nickel-chromium steels. It is felt that the results obtained up to the present are of sufficient interest to warrant their publication—as an initial instalment—before the whole scheme of work has been brought to completion, and also possibly before the time is ripe for an attempt to give a complete explanation of the observed phenomena.

The type of apparatus that was employed in the experiments follows generally that used by Andrews and his co-workers and described by them before this Institute.* The chemical composition of the steel employed in the experiments was as follows:

	Per cent.
Carbon	0.33
Silicon	0.18
Manganese	0.62
Sulphur	0.036
Phosphorus	0.038
Nickel	4.64
Chromium	1.53

The steel had been rolled to round bars, some to 1in. and some to ¾in. diameter. The bulk of the experiments were made upon the ¾in. round bars, and only a few specimens were taken from the 1in. round bars. The original diameter of the bar made no difference to the observed results. The rate of heating employed throughout the experiments was kept as nearly constant as possible. In the different experiments the variation from the customary rate was not more than 10 per cent. either way. An inert atmosphere was maintained within the tube of the dilatometer during the whole heating and cooling.

The utmost care was taken to ensure that the experimental results were reliable. The observations have been repeated frequently, and wherever any possible doubt arose the experiments were repeated a sufficient number of times to ensure that the conclusion reached was accurate.

The experiments made up to the present may be summarised as demonstrating the following results:—

(1) That the expansion that should be produced at the critical range during the cooling from the hardening temperature is not completed during the slow cooling employed.

(2) That reheating to quite low temperatures induces a further expansion.

(3) That further reheating to low temperatures brings about a contraction.

(4) That prolonged heating at low temperatures induces still further contraction.

(5) That reheating to intermediate temperatures—300 deg. to 500 deg. Cent.—induces a similar initial expansion and then a contraction.

(6) That reheating to 600 deg. Cent. induces a contraction.

(7) That the smaller initial expansion at the intermediate temperatures is likely to be the resultant of the expansion and contraction proceeding simultaneously.

(8) That the total contraction brought about at temperatures up to 200 deg. Cent. by repeated heating and cooling is less than that similarly produced at higher temperatures.

(9) That the maximum contraction brought about in any way at all the different temperatures is the same in amount.

This work is proceeding, and it is hoped that further reports may be presented in the near future, when an explanation of the observations and their practical bearings may be attempted.

Mr. E. H. Saniter regarded it as unfortunate that the authors had used the word "volume" when they were only dealing with longitudinal expansion and contraction. Their results were obscured by the fact that they had failed to give the figures for true cubic volume, which might have been very easily obtained.

Two papers, of which the following are abstracts, were taken as read:—

MAGNETIC PROPERTIES OF HEAT-TREATED CARBON STEELS.

By E. D. CAMPBELL and E. R. JOHNSON (Ann Arbor, Michigan).

The object of the present communication is to bring before the Institute some further experimental evidence in support of the hypothesis of the mechanism of permanent magnetism in bar magnets embodied in a paper submitted by the authors to the Faraday Society* in July, 1920. This hypothesis states that the force fields existing at the poles of a bar magnet represent the cumulative effect resulting from the serial alignment of the poles of the force fields of carbides or other solutes in solution.

The authors suggest the following hypothesis for the mechanism of permanent magnetism in steel, based on experiments detailed in their paper, together with the Lewis-Langmuir concept of the iron atom, including the Hull spacing of the electrons and the structure of the carbon atom. It is a well-known fact that a continuous ring of pure iron when magnetised will retain a large amount of residual inductance, whereas a straight bar of the same metal will lose practically all of its magnetism as soon as the magnetising field is cut off. In a continuous ring of pure iron, every iron atom has other iron atoms on both sides, so that when the outer electrons have been all brought into parallel planes of rotation by the imposed field, the planes of rotation of the electrons of a given atom will be maintained by the induction due to the similarly oriented electrons of the neighbouring iron atoms. On the other hand, in the case of a straight bar of pure iron, the outer electrons will, as in the case of a ring, be oriented by the imposed field into parallel planes of rotation, but as soon as the magnetising current is cut off, the outer electrons of the extreme end atoms will be drawn back into their original planes of rotation, at right angles to the cube diagonals by the induction due to the doublets of electrons of the inner shells of the atom, because on one side of the atom there is no magnetic induction to hold them against the induction due to the doublets of the electrons of the inner shells of the atoms. As soon as the outer electrons of the end atom have been drawn back into their normal position, this will remove the induction on one side of the second row of atoms, so that the second row will, like the first, have its outer electrons all drawn back into their original planes of rotation by the induction due to the inner electrons. This process would be repeated throughout the length of the bar, so that in case the bar were free from strain, there would be but little indication of permanent magnetism as soon as the magnetising current was cut off.

A BRINELL MACHINE ATTACHMENT.

By E. D. CAMPBELL (Chemical Laboratory, University of Michigan).

The object of the present paper is to describe an attachment for the standard Alpha Brinell machine, which attachment has been in use in the chemical laboratory of the University of Michigan for the past two or three years, and enables hardness measurements to be made on small bars with almost as much ease and accuracy as can be done on larger specimens, working under standard conditions. The principle involved in working is that if a small ball—2 mm. being adopted—were pressed into a smooth surface of given hardness and the image of the impression observed when a 16 mm. objective is substituted for the 48 mm. supplied with a Brinell microscope, there must be some pressure which, applied to the 2 mm. ball, would give an impression which, viewed through the 16 mm. objective, would appear the same size as an impression made with a 10 mm. ball under 3000-kilo. load on the same surface, but observed through the 48 mm. objective. A balance to replace the standard balance was constructed out of light brass tubing, the whole weighing a little over 800 grammes, or equivalent to something over 100 kilos, and this light balance was experimentally calibrated until finally, when the weight had been reduced to an equivalent of 95 kilos., the image obtained with the 2 mm. ball under 95 kilos. observed through 16 mm. objective, exactly coincided with that obtained with a 10 mm. ball under standard conditions. Comparisons were then made through a wide range of hardness, from that of ingot iron to freshly hardened hypereutectoid steels, the results obtained agreeing equally well throughout the whole range.

These papers concluded the business, and the meeting terminated with a cordial vote of thanks to the Yorkshire Philosophical Society for the use of its building and grounds for the meeting.

The social programme of the conference included a garden party on the afternoon of September 6th in the grounds of the Yorkshire Philosophical Society, when visits were paid, under the guidance of Dr. Walter E. Collings, the Keeper of the Museum, to the ruins of St. Mary's Abbey, York, and to the Roman Wall, the Multangular Tower, the Hospitium, and Roman, mediæval and other buildings in and around the beautiful grounds of the Society. After tea in the gardens a large party of the members paid a visit to the works of T. Cooke and Sons, where the various operations in the making of many kinds of optical instruments were witnessed. In the evening of the same day the President held a reception and conversazione at the Art Gallery of the city, followed by dancing. On Thursday, September 7th, a visit to Staveley, to visit the Devonshire Works—shortly described in our last issue—of the Staveley Coal and Iron Company, was made. Members were entertained at luncheon by the company. On Friday, September 8th, a visit was made to the Park Gate Iron and Steel Works, a description of which appeared in THE ENGINEER of September 1st. Here also the members were entertained at luncheon by the company, Mr. Charles Markham occupying the chair upon both occasions. Welcoming the guests, Mr. Markham, on both days, dwelt particularly on the cordial relations that existed between the workpeople, the staff and the management in both works. Mr. Markham is a very strong believer in the personal element in works organisation. He draws practically all his men from the sons and relatives of those already in the service of the company and trains them as far as possible in the works themselves. Labour troubles are practically unknown, and only one representative of a trade union is ever seen in connection with labour matters. All the workers, from the highest to the lowest, are bound together by what may be almost described as a family interest in the welfare of the two firms. He expressed himself as strongly opposed to industrial combinations and a firm believer in the individuality of companies.

* *Journal* of the Iron and Steel Institute, 1920, No. I., page 542.

* "A Force Field Dissociation Theory of Solution Applied to some Properties of Steel," "Transactions" of the Faraday Society, Vol. XVI., Part 3, page 554.

The Nations' Food Exhibition.

WHILE the members of the British Association at Hull last week were discussing vitamines, and lamenting our modern tendency to rely less and less on natural, fresh foodstuffs, there was being opened at Olympia, London, an exhibition which reveals to a startling degree the extent to which we are now catered for in the way of factory-prepared foods and beverages. Although in every corner of the kitchen and in all its adjuncts and utensils, great, almost revolutionary, developments have been made in recent years, the fact remains that the growth in the facilities for domestic cooking has been accompanied by an increased demand for foods already prepared or cooked before receipt. That the engineer has played and is playing a vital part in all food industries, is obvious to all who, visiting Olympia, can read between the lines—or see behind the stalls. His efforts in this direction have, in fact, been so successful that he has to a considerable extent nullified the value of the improvements in domestic cooking appliances and equipment, for which he himself has been largely responsible. Altogether, from the medical, the domestic and the engineering standpoints, the situation, philosophically regarded, is curiously involved and contradictory. The outcome cannot clearly be foreseen, but that the position is far from being stable is, in our judgment, established.

Of the actual engineering exhibits at Olympia, the majority are connected either with refrigeration or air conditioning. Apart, however, from these exhibits of general interest, there are others of different categories directly connected with the preparation of foodstuffs. Dough mixers, whisking machines and similar appliances for use in bakeries are shown by the Hobart Manufacturing Company and by Stavers and Stavers. Engineering development in this direction, in addition to supplying machines to take the place of the unhygienic process of making dough formerly in use, provides such items as mechanical devices for dividing buns and beating empty flour sacks. Of other machinery connected with the actual manufacture of foodstuffs, there is comparatively little, the most interesting perhaps being a wafer biscuit making and baking machine by Joseph Baker, Sons and Perkins, Limited. Chocolate coating machines by the same makers are also shown at work. The process of coating cream and other centres with chocolate is one requiring very careful regulation of temperature. Some manufacturers do not believe in the employment of machines for the purpose—the chocolates produced without machinery being styled "fork dipped." The coating process is, however, in most cases now being done with the aid of machines, the working of some of which has recently been brought to such a state of perfection that it is now possible to coat ice cream centres with chocolate and serve them with the centres still frozen.

The majority of the mechanical devices of a special nature shown at Olympia are not, however, concerned with the preparation of foodstuffs, but with their packing. In this branch very great mechanical ingenuity has been expended in the production of machines for such purposes as wrapping toffees in grease-proof paper and chocolates in tinfoil. Examples of both classes are exhibited by Joseph Baker and Perkins, Limited, and by Rose Brothers, Limited, of Gainsborough, while a chocolate foiling machine is shown by Southall and Smith, Limited. In connection with the packing of tea, custard powder, cereal foods and similar products, the equipment exhibited covers the complete range from the machinery used for printing the labels—Chambon, Limited—to highly specialised automatic machines made by Rose Brothers for packeting tea. The latter machines, as we saw them at work during a recent visit to Messrs. Lyons' new factory at Greenford, run in conjunction with electrically controlled automatic weighing machines, made by Southall and Smith, Limited, who show them at the Exhibition separately from the packeting machines. Another interesting appliance is a machine shown by Chambon, Limited, for making cardboard boxes, and lining them with grease-proof paper ready for closing after being filled with cereal food or other similar product. In this respect, it would appear that in this country many developments have yet to be made before we reach the condition attained in the matter in America. In the United States the consumption per head of the population of packeted foods and other goods greatly surpasses our figure. One American firm making "packaging" machinery alone claims that over nine million packets of food and other products are turned out on its machines per day. As a consequence, American "packaging" machinery is considerably more highly developed, or at least more elaborate, than corresponding British products. We recently examined the construction and working of some

THE GENNEVILLIERS ELECTRIC POWER STATION

(*For description see page* 270)

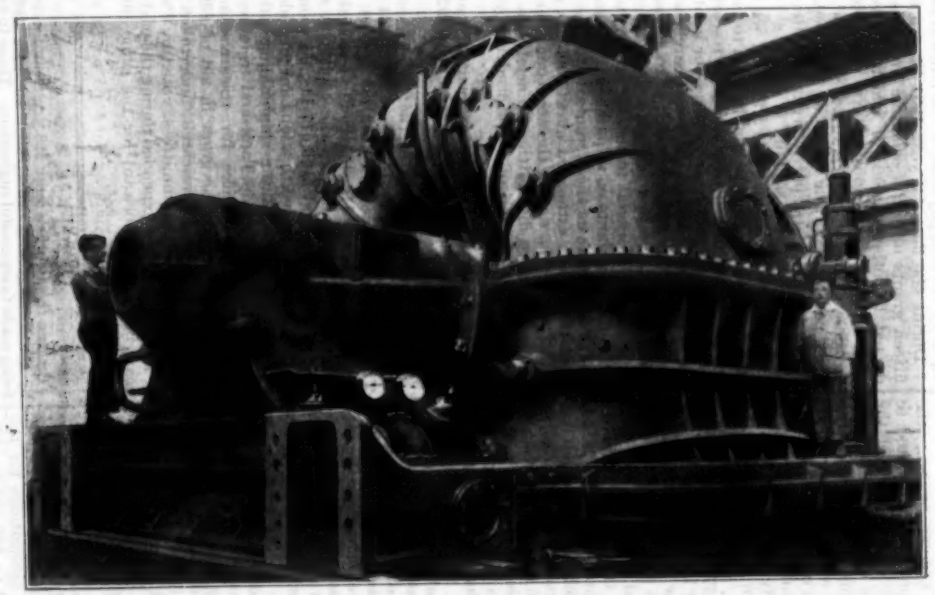


FIG. 2—40,000-KILOWATT TURBINE

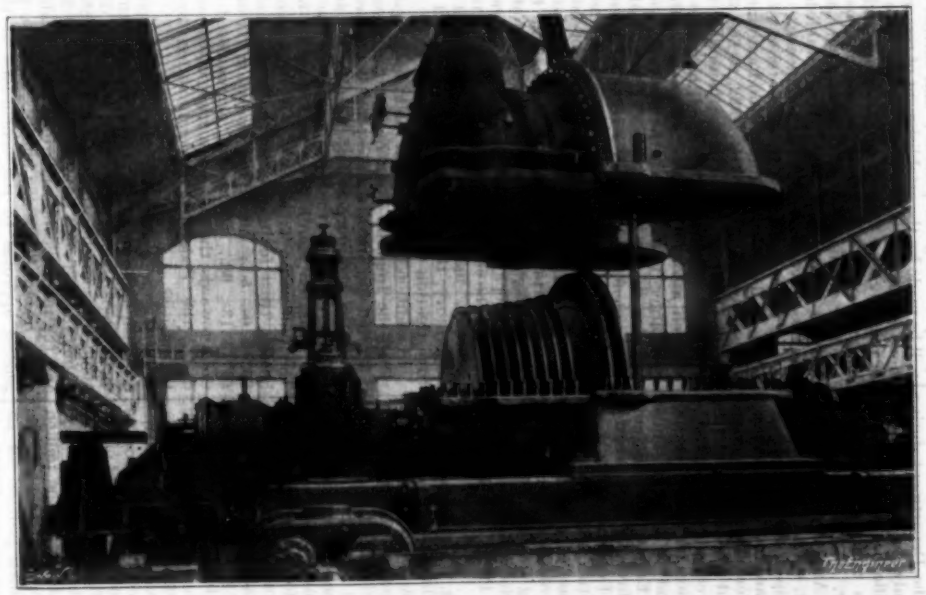


FIG. 3—TURBINE WITH COVER REMOVED

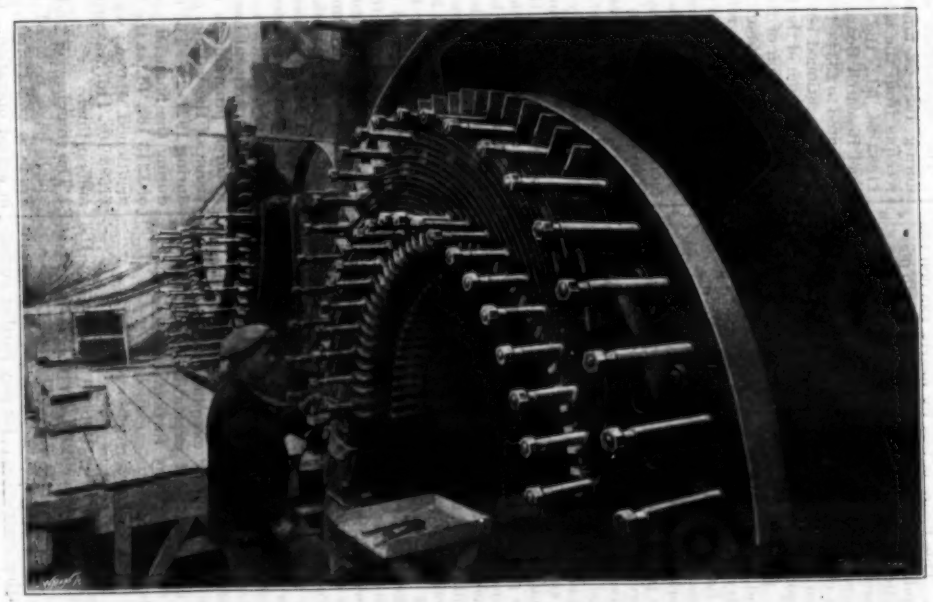


FIG. 4—PART OF STATOR FOR 40,000-KILOWATT ALTERNATOR

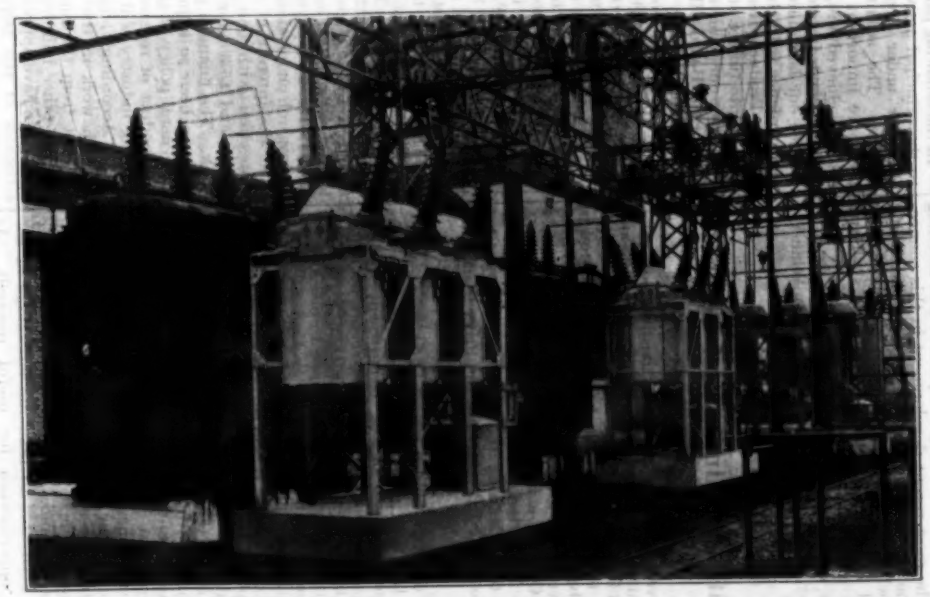


FIG. 5—AN OUTDOOR SUB-STATION

American machines which combine in one piece appliances for making the cardboard packets, lining them, weighing the goods, filling them into the packets, closing and sealing the packets and labelling them. The most recent development in this connection in the United States consists of a wet wrapping process, whereby a damp one-piece paper wrapper is applied to the outside of the cardboard shell and sealed by gluing to form a perfectly air-tight case. So far as we are aware, this process has not been adopted by any British maker of packeting machinery.

Scientific and Industrial Research.

No. I.

THE seventh annual report of the proceedings of the Committee of the Privy Council for Scientific and Industrial Research, covering the period from August 1st, 1921, to July 31st, 1922, has been issued, and is reprinted below. As usual, the report is followed by a detailed account of the work done by the Committee's Advisory Council, a summary of which we hope to give in a future issue. The Committee's report is addressed to his Majesty the King, and is signed by Lord Balfour, Lord President of the Privy Council.

During the year under review, our most serious attention has been given to the steps necessary to restrict the estimates of the Department for the financial year 1922–23. In our last report we called attention to the steps taken more than a year ago to curtail the provision we had hoped to make under normal peace conditions for the development of the work of the Department. The action then taken was carefully considered by the Advisory Council, and in their report the Council present a detailed account of the continuous thought they have given to this problem. As the Council point out, the outlook of the Department has, from its establishment in 1916, been one of peace conditions. They had laid their plans in the hope that the Department might develop "without undue haste, but with steady progress, the organisation of our national resources for scientific and industrial research in so far as these call for Government assistance in the national interest." In happier circumstances, the Department would by now have been able to take full advantage of the increasing opportunities for useful research. As matters stand, however, this is for the moment impossible. The actual net expenditure of the Department from public funds, exclusive of grants to research associations from the capital of the million fund, amounted during 1920–21 to £427,432 9s. 11d., and during 1921–22 to £338,552 2s. 10d. For the current financial year ending March 31st, 1923, we have provided from the same sources a sum of £342,641. This figure is less by nearly £85,000 than the expenditure in 1920–21, but about £40,000 of this reduction is the result of the Government decision that research work undertaken directly for the fighting services at the National Physical Laboratory shall be a charge on the votes of those Departments and not on the Research Department's vote.

The report of the Advisory Council refers to the increased provision they would have wished to recommend, but for the present financial position of the country. The curtailment they have, in fact, proposed has undoubtedly involved a slowing down of the research programme and the postponement of certain work which would have been undertaken now had funds permitted. But the curtailment of actual expenditure has not interrupted good work already in hand, because the plans of the Council had been so prepared as to mature over a period of years as the increasing number of trained research workers became available, and as the work could be organised efficiently and economically. While we deplore the necessity which has prevented the more rapid development of the programmes of the Advisory Council, we recognise that the need for economy has inflicted less injury on the fulfilment of the purposes which it is our duty to carry out than would have been the case if the check had come at a later stage. For, indeed, a steady policy in the matter of research is more conducive to its success than the provision of larger sums of money without the assurance of their continuance.

For this reason it was a special satisfaction to us that the Committee on National Expenditure, established by the Government a year ago, did not find it necessary to recommend any reduction in the estimates of the Department beyond that which we had ourselves proposed. The Committee reported:—"We are of opinion that the activities of this Department have been minutely examined with a view to obtaining a reduction of expenditure, and we are unable to recommend any further reduction beyond what has been effected."

* * * * * *

We hope that the drastic steps taken by the Advisory Council to readjust their programme to the critical conditions of the times may make it possible to carry on the work of the Department without further restriction; for any further curtailment of funds would not only involve the discontinuance of important work now being undertaken, but would seriously affect the number of competent investigators coming forward—a set-back from which the country would be long in recovering, if indeed the injury were not lasting.

In the following paragraphs we make brief reference to the principal activities of the Department during the year under review, mainly in their financial aspects. The scientific significance of the work, the more important problems undertaken and the results achieved are, however, discussed at length in the appended report of our Advisory Council.

Since our last annual report, we have established, in accordance with the directions of the Government, a Forest Products Research Board to conduct investigations into timber and other forest products derived both from our home supply and from overseas. The work of the Board will thus be complementary to the work of the Forestry Commission on the cultivation of timber in this country, and to that of similar organisations throughout the Empire, in the same way as the work of the Food Investigation Board is complementary to that of the Departments of Agriculture and Fisheries in the British Isles and of other research organisations overseas concerned in the production of the food supply of these islands. We have been fortunate in securing the services of Professor J. B. Farmer, F.R.S., as chairman of the Board, and of Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., F.R.S., as director of research.

We pointed out last year that, with the completion of its war activities, the expenditure of the National Physical Laboratory had now been adjusted to normal conditions. The expenditure of the Laboratory during 1921–22 amounted to £190,024 1s. 5d., of which £42,720 16s. 4d. was provided from fees for tests and special investigations for outside bodies, £50,242 15s. by repayments from the fighting services for research undertaken directly for them, £243 16s. 4d. from the interest of the million fund for work in connection with one of the researches mentioned below, and £5398 for research work in the Froude Tank. The financial provision for the Froude Tank has now been so adjusted that, in conformity with the general policy of the Advisory Council, funds for the conduct of research for the benefit of the shipbuilding industry will be secured on a co-operative basis. Accordingly, one-half, £2699, of the cost of the research work in the Froude Tank during 1921–22 was met from the funds provided by the industry, and the other half from the interest of the million fund. We have approved a recommendation that the estimates of the Department shall provide for an expenditure on this work not exceeding £5000 per annum for the next three years, on condition that one half of the actual expenditure as incurred will be met from the funds provided by the industry. We shall continue to provide from the interest of the million fund the half share of the expenditure which, under these arrangements, is to be met from the funds of the Department.

The expenditure on the Fuel Research Station during 1921–22 amounted to £43,266 5s. 8d.; the receipts from the sales of by-products amounted to £1883 8s. 5d.; the expenditure on the work of the Fuel Research Board, elsewhere than at the Station, amounted to £3349 10s. 9d., exclusive of three of the grants mentioned below, which were made on the recommendation of the Board at a cost of £1537 11s. 9d.

The extension of the programme of the Geological Survey and Museum, especially in relation to its economic work, as referred to in our last report, has continued during the past year, and the expenditure during 1921–22 amounted to £57,423 3s. 10d.

For the work of the Building Research Board, the facilities provided by the new Building Research Station at Acton, to which we referred in our last report, have been available and the work has been carried on more effectively and thoroughly. The expenditure during the year amounted to £10,323 2s. 4d.

The Low Temperature Research Station, which our grants have enabled the University of Cambridge to erect and equip for the work of the Food Investigation Board, has now been completed, and the special installation is being adjusted to running conditions. The total expenditure of the Board during 1921–22 amounted to £17,750 1s. 10d.

The co-ordinating boards and their committees, to which we referred in our last report, have made steady progress with their work during the past year, and the total expenditure amounted to £21,464 7s. 6d., including estimated amounts payable to other Departments for agency work. In addition, an expenditure of £5380 11s. 5d. was incurred for work for these boards and committees at the National Physical Laboratory.

The Department has conducted work on nine other research programmes carried out under the supervision of the various committees of the Department during 1921–22. The total expenditure on this work during the financial year, excluding the expenditure of £243 16s. 4d. at the National Physical Laboratory, mentioned above, was £5987 11s. 8d., of which £1698 10s. 11d. was provided from the interest of the million fund.

The number of industrial research associations which have received licences from the Board of Trade is twenty-four, and of these twenty-two are in actual operation. Grants to associations for the financial year 1921–22 amounted to £86,355 5s. 1d., and the balance of the million fund remaining unexpended on March 31st, 1922, amounted to £816,850 3s. 9d. Part of this balance has been earmarked to complete the payments of grants to the associations named during the currency of their quinquennial grant periods; and further calls on it will be made by the establishment of research associations which have not yet been formed. In the report of our Advisory Council an indication is given of the progress made by research associations to date, together with a general discussion of some of the features of interest which their establishment and progress have brought into prominence.

The income provided by the interest of the unexpended balance of the million fund amounted, during the year ending March 31st, 1922, to £65,358 11s. 3d. It will be observed that notwithstanding the reduction in the capital of the fund, owing to grants to research associations, the receipt from the interest was larger than during the previous year. This was due to the reinvestment of the fund in other Government securities, as a result of which interest for five quarters was received within the financial year, while a more favourable rate of interest was secured. After applying £8125 16s. 2d. to meet the cost of certain industrial researches, the balance of £57,232 15s. 1d. was appropriated in aid of the Vote of the Department, through which it was applied towards the cost of research work of value to industry generally, undertaken by the National Physical Laboratory, the Fuel Research Board and the Food Investigation Board.

In addition to the million fund for research associations, the Imperial Trust for the Encouragement of Scientific and Industrial Research holds certain other funds for the purposes of the Department. The balances of these funds appearing in the books of the Trust on March 31st, 1922, were as follows:—The Williamson Trust, £345 3s. 11d.; various funds held in trust for the National Physical Laboratory, £3315 0s. 5d.; the Superannuation Trust Funds, £3714 13s. 9d., representing accumulated contributions towards the superannuation of certain officers under the Federated Superannuation System for Universities.

The Interdepartmental Committee appointed to establish uniformity of procedure between Government Departments in dealing with the discoveries made by scientific workers aided or maintained by public funds, issued its report on October 5th, 1921, and the main recommendations are indicated in the report of our Advisory Council. We have given our general approval to the conclusions of the Interdepartmental Committee, and have submitted its report to the Lords Commissioners of your Majesty's Treasury for their consideration.

During the past year, five applications for patents have been filed by the Imperial Trust, in conjunction with the respective inventors. Five applications outstanding from the previous year were not proceeded with and five patents have been allowed to lapse by the non-payment of the renewal fees.

During the financial year 1921–22, we have made fifteen grants in aid of scientific investigations conducted by other bodies, of which twelve were in continuation of previous grants. The expenditure on these grants amounted to £8287 8s. 3d., and was met, partly from the Vote of the Department—£4802 19s. 4d.—and partly from the interest of the million fund—£3484 8s. 11d.

During the academic year 1921–22, we made 205 allowances to students to enable them to take advantage of the facilities for training in research offered by various universities and colleges or in other ways. We made fifty-five grants to research workers to undertake independent research or to act as scientific assistants to investigators. We made twenty grants to scientific workers to enable them to employ laboratory assistants or to purchase equipment. The total expenditure on these grants during the academic year 1921–22 is estimated at £47,005, as compared with £39,191 14s. during the academic year 1920–21. The expenditure during the financial year 1921–22, covering half of each of these academic years, was £43,793 4s. 8d.

The expenditure of the Department on headquarters administration during the financial year 1921–22 was £37,560 16s. 7d.

The total expenditure of the Department during the financial year 1921–22 was £525,584 19s. 7d. This sum was made up of £273,193 11s. 7d. from the Exchequer, £65,358 11s. 3d. the interest of the million fund, £86,355 5s. 1d. from the capital to the fund, referred to above, and £100,677 11s. 8d. from fees for tests and special investigations for outside bodies, from contributions of the shipbuilding industry for research in the Froude Tank and from repayments by the fighting services for research undertaken directly for them. The grant in aid of £39,500 for the development of research undertaken by our various boards and committees, voted by Parliament in 1921–22, was not expended during the past financial year, but carried forward for the same purpose to 1922–23.

DURING the month of July, 369 suggestions were received by the Underground management from its staff, awards being made to successful suggestions. Those to be adopted include:—(1) Electrical ticket-cancelling apparatus; (2) a poster design; (3) springs for top-deck seats of omnibuses; and (4) "Safety First" slogans.

A Seven-Day Journal.

The Circuit of Britain Air Race.

AFTER an exciting contest, the race for the King's Cup over a course of 810 miles was won by Mr. F. L. Barnard on a de Havilland 4a machine, equipped with a 350 horse-power Rolls-Royce "Eagle" engine. Of the twenty-one machines which started from Croydon last Friday morning, thirteen reached Glasgow, *viâ* Birmingham and Newcastle, on the evening of the first day, and of these thirteen eleven returned to Croydon, *viâ* Manchester and Bristol, on the following day. It is a noteworthy fact that the winning machine has been in the cross-Channel service of the Instone Air Line since 1919, and that six out of the eleven machines which completed the circuit were of the de Havilland design. Second place was secured by a Martinsyde F6 machine, the Vickers Vulcan coming in seventh, the Sopwith Gnu eighth, and two Boulton and Paul machines ninth and eleventh. Considerable difficulty was experienced in settling the handicaps for the machines beforehand, for the strength of the wind could not be definitely forecast. An element of chance was thus introduced into the race, for wind affects the speed of an aeroplane to a degree dependent upon its size. As it was, Mr. Barnard's machine was handicapped to leave Croydon last but one, and nearly two hours after the first departure. Yet it was the second to reach Newcastle, the first to reach Glasgow, the third to reach Manchester, the second to reach Bristol, and the first home.

Disinfecting Liners.

ACCORDING to Dr. E. W. Hope, port medical officer at Liverpool, the use of hydrocyanic acid gas—prussic acid gas—for disinfecting liners is likely, in spite of its highly poisonous nature, to become the routine fumigant in the near future, in view of the efficacy with which it destroys rats and vermin without bleaching or otherwise damaging fabrics and decorations. The procedure adopted at Liverpool in connection with the Cunard liner Scythia, the first vessel to be fumigated with hydrocyanic acid gas in this country, was to seal her up as nearly air-tight as possible, and then to generate the gas within her, one barrel of the chemical being used for every 45,000 cubic feet of interior space. After an interval of two hours the vessel was opened up from the top downwards, and left open for a time for the gas to clear. Not until every part of the vessel had been tested by means of live rats in a cage was the vessel pronounced safe for general use. At the present moment Dr. R. J. Reece, Senior Medical Officer in the Sanitary Administration Branch of the Ministry of Health, together with members of his staff, is now in America for the purpose of compiling a report on the methods of using this fumigant there employed. It is largely as a result of the action of the United States Public Health Department that hydrocyanic acid gas is being forced upon shipowners as a fumigant.

The High Level Bridge at Newcastle.

PRELIMINARY work, we are informed, has already begun in connection with the re-flooring of the Newcastle High Level Bridge to permit of a double tramway track being run across the bridge to connect the Newcastle and Gateshead tramway services. It will probably be necessary to close the bridge to vehicular traffic for about a month, but the side paths will remain open to pedestrians during this period. The work now being done is preliminary to the laying of the new flooring. The old timber is being removed and will be replaced by transverse steel girders, which along with existing girders suspended from the cast iron arches will support the new flooring and the new tramway lines. It is hoped that the work will be finished by the end of November, and that the new tramway service will be inaugurated early in December. The High Level Bridge, which is one of the notable bridges built by Robert Stephenson, can only accommodate vehicles having a weight less than 7 tons, and during the time it remains closed the traffic will be diverted to the Swing Bridge and the Redheugh Bridge. It is stated that the work of alteration, which is being done under contract for the North-Eastern Railway Company, will cost in the neighbourhood of £22,000, of which six-elevenths is to be borne by the Newcastle Corporation.

Reconditioning the Leviathan.

FURTHER to our Note in the Journal of June 9th, concerning the reconditioning of the ex-German liner Vaterland at the Newport News Yard of the Newport News Dry Dock and Shipbuilding Company, Virginia, an interesting report on the progress of the work has recently been made to the United States Shipping Board by Rear-Admiral W. S. Benson, Commissioner in Charge of Construction. Admiral Benson expresses satisfaction with the way in which the work of overhaul and refitting is being carried out, and records his opinion that the new equipment and the rearrangement of the internal structure of the ship will result in a safer and better vessel in every way. The new arrangement, we understand, will increase the stability of the ship. All bulkheads below the water-line have been materially strengthened, and fireproof partitions have been inserted at distances of 133ft., making it possible to confine a fire to the space between these partitions. The water-tight doors have been reduced in number by 50 per cent., and those remaining are so to be arranged that the ship may be worked without inconvenience with all water-tight doors below water-line closed. All possible precautions have been taken to safeguard the ship, either in case of collision, fire or grounding, and when she is commissioned next spring the Leviathan will undoubtedly be a fine example of her class and type.

Across the Channel on a Glider.

THE development of the engineless aeroplane has now proceeded so far that a well-known cross-Channel pilot, Captain E. D. G. Herne, of the Daimler Airway Services, is seriously proposing to glide across the Channel on a motorless machine. A machine for the purpose is now being constructed by the de Havilland Aeroplane Company, and the attempt, it is hoped, will be made before the end of the year. The necessary height from which to make the glide will be obtained from the high cliffs along the Kent coast. In this respect reliance is being placed for additional assistance from the almost constant vertical currents of air which observation shows are met with in the neighbourhood of those cliffs.

Loss of a Hamburg-Amerika Liner.

A SINGULAR catastrophe took place on the afternoon of Saturday last, when the Hamburg-Amerika liner Hammonia, a passenger and cargo vessel of some 7197 tons gross, filled up and sank in heavy weather about 100 miles off Vigo. The Hammonia was to inaugurate a new service to Tampico and intermediate ports, and after leaving Hamburg called at Plymouth and Vigo. On leaving the latter port on Friday last, with a complement of 365 passengers and 192 officers and crew, the vessel encountered heavy weather, and it was found that she was making water more rapidly than the pumps could discharge. On Saturday morning the vessel had developed a heavy list to starboard, and S O S signals were sent out. The signals were quickly responded to by Captain Day, of the Union-Castle liner Kinfauns Castle, proceeding from Madeira to Southampton, who was able to rescue over 385 persons. Other vessels, including the Euclid, the Soldier Prince and the City of Valentia, took part in the work of rescue, and the total loss of life is said not to exceed some sixteen persons. No cause has yet been assigned to the disaster, but in some reports mention is made of defects in the closing of the coal ports. Captain E. W. Day, the commander of the Kinfauns Castle, is one of the best known and most popular commanders in the South African trade, and his service on this occasion has added to his already remarkable record of life-saving.

Dixon's Blazes to Restart.

IT is announced that the Govanhill Ironworks, situated in Crown-street, Glasgow, and perhaps better known by the popular name of Dixon's Blazes, are, after being closed down for some considerable time, to resume operations. Negotiations connected with the restarting of the works are now being conducted between the management, and the officials of the Iron and Steel Trades Confederation, to which the men are attached, and we understand that the re-opening will be subject to the acceptance of certain conditions by the workmen to be employed. It is reported that men are already preparing for the lighting up of the furnaces, which process usually takes about a fortnight. It is hoped that this step indicates a better outlook in the iron and steel trades.

Unwanted Steamships.

SPEAKING at the launch of the British Monarch, which took place on the Clyde at the Old Kilpatrick Yard of Napier and Miller on Monday last, Sir William H. Raeburn said that that fine vessel, although much in advance of anything previously built for her owners, Raeburn and Verel, was not now required. He could not say honestly that he was glad to add her even to their attenuated fleet, and unless freight conditions improved greatly, as soon as she was completed she would have to join the ranks of the unemployed in the Gareloch. The order for that ship was placed 2½ years ago, and if she had been delivered as expected in 1921, it was possible that she might have had some profitable employment, but in the intervening period of strikes and delays, freights had fallen below a paying level. At the present time it was not possible to operate a high-class tramp vessel without loss, even although no allowance was made for depreciation and interest, on a pre-war basis. The price of the British Monarch worked out at about four times the cost of her sister ship laid down in 1915. The reciprocating steam engine and even the geared turbine would have to give place to more economical machinery, and if he were again building he would certainly be inclined to look towards the Diesel engine. The British Monarch is a cargo boat of 5660 tons gross, having a length of 420ft. and a speed of 13½ knots. She is to be fitted with Brown Curtis turbine machinery, and her boilers will be equipped both for coal and oil burning, the oil being carried in the double bottom.

Kelham and Cantley Beet Sugar Factories.

WE understand that in consequence of a working arrangement entered into, with a view to the future amalgamation of the Kelham and Cantley beet sugar schemes, it has been arranged that this year the sugar beet crops of the Kelham growers shall be worked at the Cantley factory. It is stated that by dealing with the total acreage of beet now being grown in this country — upwards of 8000 acres — at one factory working at its full capacity, it is hoped to achieve the lowest economic cost of sugar production, and thus secure figures which will be valuable for future guidance. In the meantime, proposals are being considered for the extension and improvement of the Kelham factory, so that a similar plan of working may be carried out there in future seasons. The beet contracts department of Home-grown Sugar, Limited (Kelham) has been placed at the disposal of the English Beet Sugar Corporation, Limited (Cantley), for the present campaign, and Mr. Alfred Wood, F.C.A., the secretary of Home-grown Sugar, Limited, has agreed to act as the assistant secretary of the English Beet Sugar Corporation.

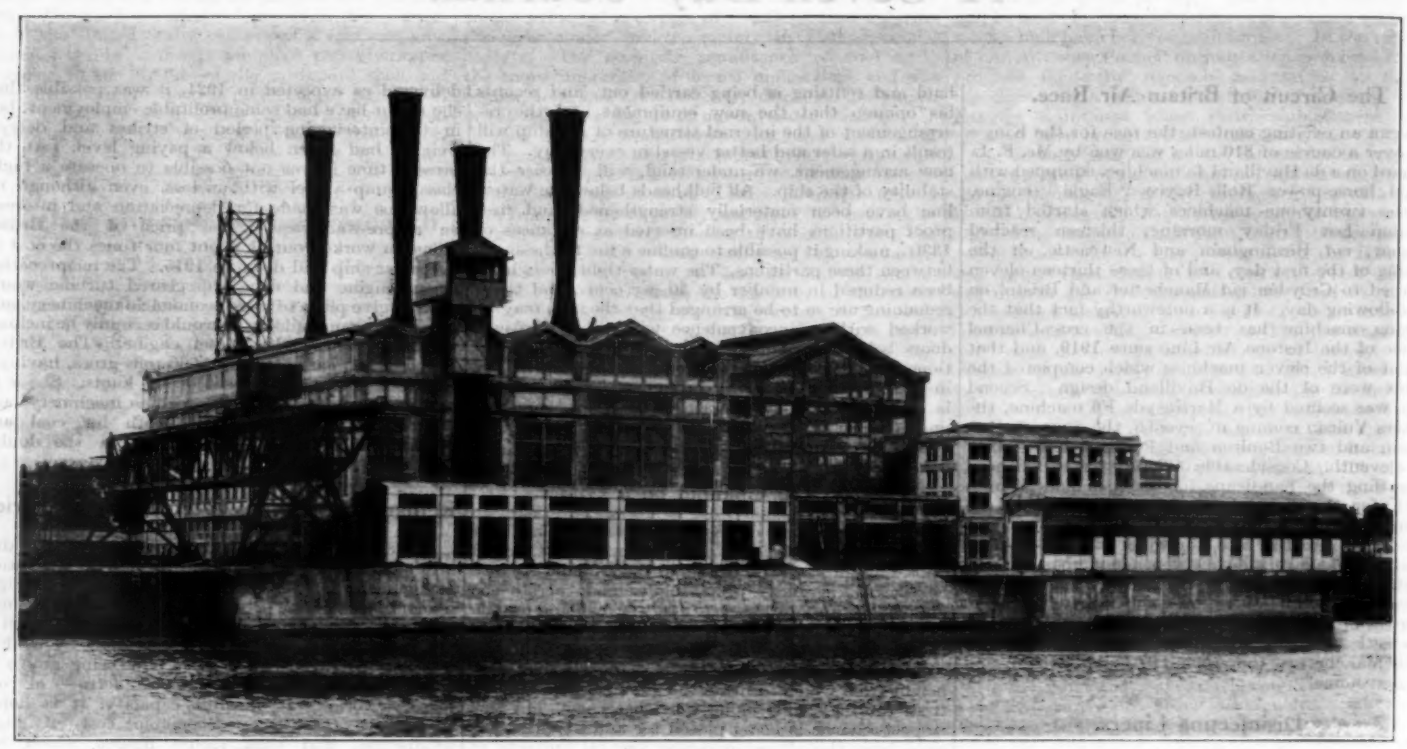
The Duct Keel.

THE recent successful trials of the steamer Manchester Regiment and the launching of the Nataliania have aroused interest in the duct keel system of ship construction. In a duct keel vessel the main longitudinal member of the double bottom framing, instead of being a single vertical plate, is made in the form of a box-shaped girder. The size and design of this box girder are such that it becomes possible to do away with any cross-stiffening members within the girder itself, and, moreover, the joints are made so that they are oil-tight and water-tight. The duct keel provides a clear fore and aft passage between the flat keel plate and the gutter plate or centre line tank top plate, which is of the greatest value for accommodating the bilge piping. With this new system it becomes possible to make all necessary connections on the bilge piping and oil fuel systems without the piercing of water-tight bulkheads. The arrangement of pipes in the duct keel also permits ready access for examination, and the danger of damage to cargo by leaking pipes is eliminated. The system would seem to supply a solution for piping difficulties. We understand that the trials which have been made on large cargo-carrying vessels have proved satisfactory.

A New Graving Dock on the Wear.

CONSIDERABLE improvements are now being carried out on the Wear, which will, when complete, greatly enhance the importance of the port of Sunderland. Work has already been begun on the new extension quay which is being constructed jointly by the Sunderland Corporation and the River Wear Commissioners. Another important undertaking is the construction of a new graving dock for T. W. Greenwell and Co., which has been entrusted to Sir William Arrol and Co., Limited, of Glasgow, and should be completed within about fifteen months. The new dock is to be 75ft. wide at the entrance, and will accommodate vessels up to 500ft. in length. Provision has been made for the docking of even larger vessels, should the depth of water at the river mouth permit of so doing, and the dock is to be so constructed that by removing a thin shell which is to form the top of the dock, another hundred feet may be added to its length. The Commissioners are also preparing to lay the caisson at the end of the new south pier, which when ready will permit the work of removing the old piers to be begun. Part of the bay now used as shipbreaking ground will be filled in, and in place of the old south pier it is proposed to construct breakwaters to ensure the safety of craft in the river.

GENNEVILLIERS POWER STATION ON THE SEINE



The Gennevilliers Electric Power Station.

No. II.*

A VIEW of the station as it appears from the river Seine is shown above, whilst Fig. 7 gives a fair idea of the internal arrangements, and Fig. 8 is an elevation of one of the 40,000-kilowatt turbo-generator sets. Water for cooling the transformers, cleaning, and for fire protection, &c., is drawn from the intake by means of three large pumps, two of which are motor driven, whilst the third is operated by steam. These pumps discharge through a common main into two large filter basins, and the filtered water is delivered into two tanks, having a capacity of 48 cubic metres (about 1660 cubic feet). A battery of motor-driven pumps lifts the water into a large reservoir, from which it is fed into the service mains, and is also delivered to a pump which deals with the water that has to be purified. This water, which is treated by a plant working on the Kestner hot chemical system, is discharged into a storage tank, and is then converted into steam by two Babcock boilers specially designed for the purpose.

The condensate from the main condensers is circulated through the air coolers of the electric generators, and on leaving these coolers the water is passed through pre-heaters which are operated with steam extracted from the turbines. At the outlet of these preheaters, the temperature of the water at full load is 90 deg. Cent., or 75 deg. at half load. The condensate is then discharged into the hot wells, which are supplied with exhaust steam from the main boiler feed pumps, the turbine-driven auxiliaries, and, if necessary, steam extracted from the 3000-kilowatt auxiliary turbo-generator sets, the temperature of the water being increased in this way to 100 deg. Cent. From the hot wells the condensate then passes through degassers—see Fig. 6—working on the Paul Kestner system, and all traces of dissolved oxygen and carbonic acid gas are removed. The water is then pumped into the economisers by the main boiler feed pumps. There are nine of these pumps, six of them being driven by 420 horse-power motors and three by steam turbines of the same capacity. In order to maintain the salt content in the water at a minimum, a certain quantity of the boiler water is

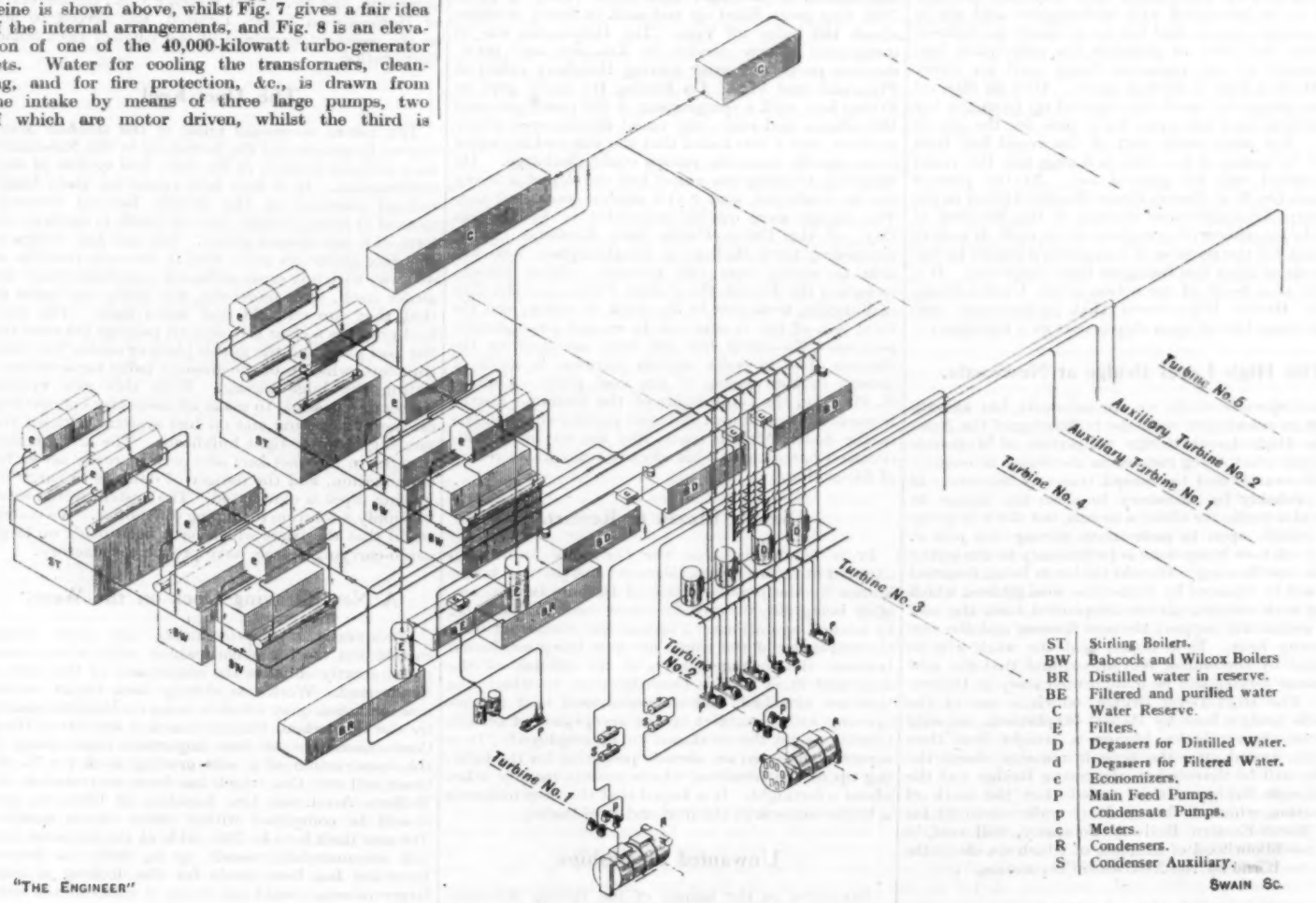


FIG. 6—CONDENSATE PIPE SYSTEM

* No. I. appeared September 8th.

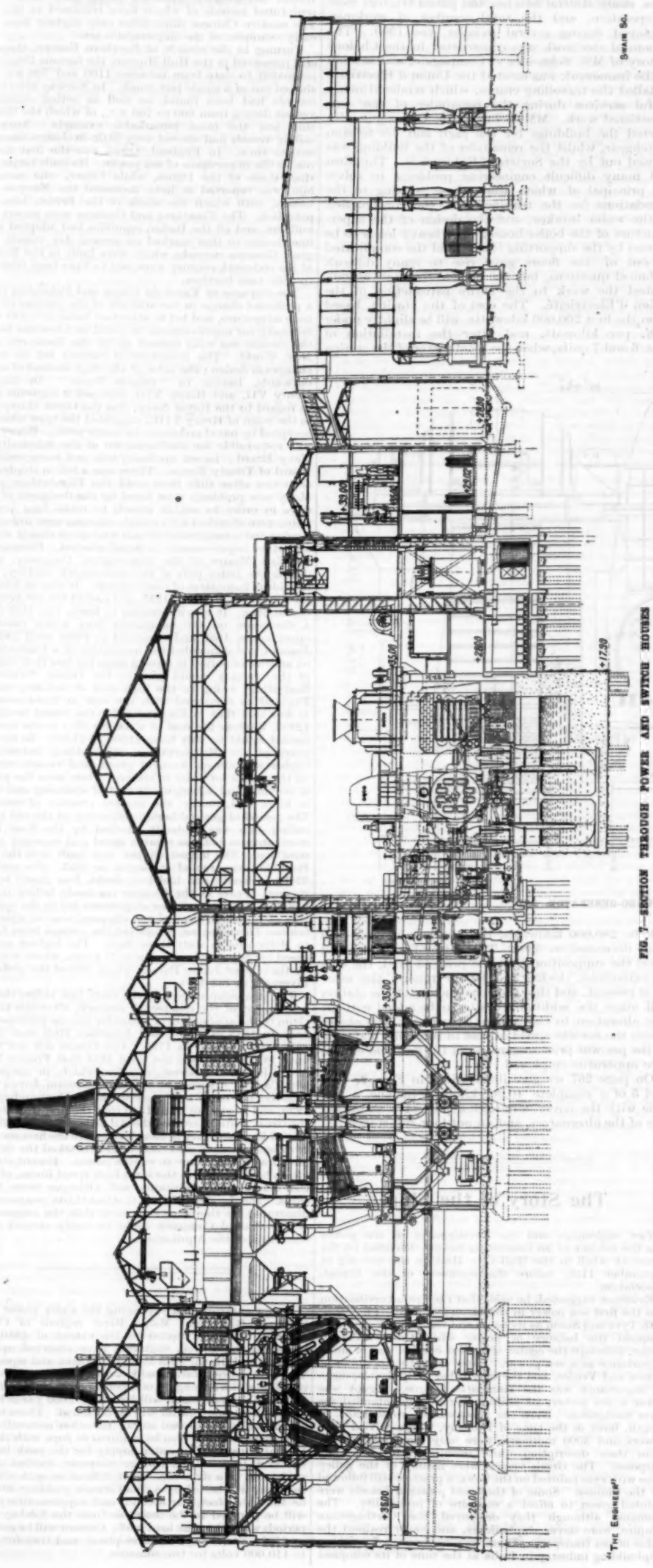


FIG. 7—SECTION THROUGH POWER AND SWITCH HOUSES

GENNEVILLIERS ELECTRIC POWER STATION

continuously passed back into the hot well. A central fire main, with a series of branches, has been provided, and it can either be fed from the storage reservoir or from the main water intake. A special main has also been installed for giving a supply of water for general cleaning purposes, and a main for cleaning the condensers. There is also a vacuum main for enabling dust to be removed from various parts of the station by the use of the vacuum cleaning process. The oil service plant has been placed in a separate building, some distance from the main station. The building is divided into three separate sections, which contain oil tanks, pumping plant for filling and emptying the tanks, apparatus for treating the oil, filters and heaters, and the oil-distributing pumps.

The Electrical Plant.

The electrical part of the station is divided into the same number of sections as there are generating units, and each section contains a main oil circuit breaker, three sets of disconnecting switches, which enable the units to be connected to either one of three sets of bus-bars, six sets of feeder disconnecting switches, three current limiting reactances for separating the different sections of the bus-bars, and an oil circuit breaker for sectionalising the different sections of the bus-bars. All the oil circuit breakers, with the exception of those used for the auxiliary sets, are of the same type, and have a normal rupturing capacity of 600,000 kilowatts. They were designed by the General Electric Company, and manufactured by the Compagnie Française Thomson-Houston. Although the oil circuit breakers are of the automatic type, they do not operate under overload conditions, as the generators have been designed to withstand the full short-circuit current when working with normal excitation. A differential relay protection system is provided to trip the oil circuit breaker in the event of a fault occurring within a generator, or in one of the step-up transformers. The feeder oil circuit breakers are also fitted with differential relay protective gear. Each breaker is installed in a three-cell reinforced concrete compartment, enclosed in a steel sheet case, and a drainage system is provided to enable the oil to be withdrawn in the case of fire. The oil-immersed reactors are held rigidly in position by means of bronze bolts, but sufficient elasticity is provided by the use of Belville spring washers. A special bus-bar is provided for testing purposes. All the switchgear is of the outdoor type, but the spacing of the conductors is the same as that adopted on indoor switchgear, and in order to facilitate the maintenance of the gear it is enclosed in a light housing composed of reinforced concrete. A gallery, extending around the building, enables all the conductors and insulators to be easily inspected. Standard gauge tracks have been laid in the principal bays in order to connect the building with the railway outside.

The low-tension switchboards and switchgear are placed in a large building, extending along the entire length of the turbine-room, and situated between the latter and the building containing the high-tension apparatus. This building has three floors. The first contains laboratories and the cells for the step-down transformers, the second the 3000-volt apparatus, and the third, which is separated from the turbine-room by a glass partition, the switchboards upon which the meters, instruments and control buttons are mounted for operating the 60,000 and 3000-volt circuits, the 500-volt direct-current and the 220-volt alternating-current circuits for the small auxiliary motors and the station lighting. The 6000–60,000-volt step-up transformers are enclosed in a series of separate cells situated in the main turbine-room on the side adjacent to the switchgear. Each cell is composed of a structural steel frame with reinforced concrete walls, a ventilating opening being provided for the escape of fumes in the event of fire. Under each cell there is an oil reservoir of sufficient capacity to take the oil of the transformer above. In a corridor extending in front of the cells there are thermometers and valves for regulating the cooling water, oil levels, &c., and also switches for earthing the neutral points.

Equipment.

In the laboratories, already referred to, the necessary apparatus has been installed for carrying out mechanical tests upon materials, and tests upon oil and coal, whilst one of the laboratories has been equipped with the necessary electrical apparatus for carrying out high potential tests. This laboratory is provided with a 6000-kilovolt-ampère motor generator set, and a testing transformer for testing feeders up to twice their normal voltage. In the repair shop there is, in addition to the usual equipment for carrying out repairs, an electrically heated drying and baking oven, which is capable of accommodating a complete alternator field. At a later date a smaller oven is to be installed for use in connection with the repair of small motors and transformers. There is also a blacksmiths' shop.

Two travelling cranes in the turbine-room of the station operate at different levels, one of the cranes having a capacity of 100 tons and the other 20 tons. There is also a 40-ton crane which is used for lifting the transformers from their pits without dismantling them or draining off the oil. The repair shops are

equipped with a 60-ton and two 15-ton travelling cranes, whilst the boiler-house is provided with a 10-ton travelling crane which can load or unload material directly from trucks on the boiler-house siding. For handling the coal there are two unloading bridge cranes, with a travelling pivoted unloading arm, a travelling hopper, and a double belt conveyor. Coal can be delivered from the barges at the rate of 200 tons per hour, either to the storage yard or direct to the boiler-house, or it can be taken from the storage and be transported to the boiler-house at the rate of 200 tons per hour. For the delivery of the coal to the boiler-house the belt conveyors of the unloading bridge discharge into motor-driven dumping cars, each having a capacity of 20 tons, and running on a track. The dumping cars discharge the coal into fixed bins, which in turn feed two bucket elevators, each having a capacity of 200 tons per hour. They are fed by metallic travelling belts, and each belt receives its charge from two reinforced concrete bins, which can either be filled from the motor-driven dumping cars, from the rail cars direct, or from auxiliary motor-operated cars, which collect the fine coal which has fallen through the gratings. The bucket elevators discharge into a fixed bin, from which 2-ton rail distributing cars are charged, and these cars serve the individual boiler hoppers. The total capacity of the boiler coal hoppers is 3800 tons. Whilst, as stated above, the railroad cars can discharge directly into the chain elevator bins, two railroad sidings extend along the entire length of the storage yard from north to south, thus permitting the railroad cars to be unloaded directly into the pits, from which the coal is gathered by the bridge cranes and is stacked in piles. At convenient points on the two sidings tilting platforms have been installed.

All the boilers, economisers and preheaters are fitted with air nozzles, which enable the soot to be blown off the tubes by means of compressed air, and the soot is collected in metallic hoppers which can be emptied directly into cars, each having a capacity of 40 tons and operating on standard gauge tracks. The cars are emptied by a tilting elevator into a large storage bin. For about a year the ashes will be used for filling and grading the yard around the station, but at the end of that period they will be employed in the manufacture of briquettes, and a plant is being designed which will extract the particles of coke remaining in the ashes.

A separate office building has been erected for the management and engineering departments, and passages from this building lead to the main turbine-room and the main switchboard. The buildings reserved for the workmen are provided with locker rooms, baths, a dispensary, and a dining hall, &c. Special apartments have been provided for the managing and engineering departments and also the leading foremen, all of which are equipped with electric heating and cooking appliances.

BUILDINGS.

The foundations of all the buildings are supported upon concrete piles, which vary in length according to their situation. The framework of the turbine-room is composed of steel, whilst those of the boiler-house and high-tension switch houses are composed of reinforced concrete. By the employment of a large amount of machinery the buildings were constructed in a remarkably short space of time. At one period five steam pile-drivers, one excavator, two locomotives, many electric winches and petrol tractors were in operation, and the total number of workmen employed during several months was 1300. The structural steelwork was constructed in the Châlons factory of MM. Schneider et Compagnie, and as soon as the framework was erected the Union d'Electricité installed the travelling cranes, which rendered many useful services during the remainder of the constructional work. MM. Schneider et Compagnie also erected the buildings for the high and low-tension switchgear, whilst the remainder of the building was carried out by the Société d'Enterprises. This firm had many difficult engineering problems to solve, the principal of which were those relating to the foundations for the turbine-room, the construction of the water intakes, and the design of the superstructure of the boiler-house. The heavy loads to be carried by the supporting frames and the complicated lay-out of the floors gave rise to many difficult technical questions, but the Société Générale accomplished the work to the entire satisfaction of the Union d'Electricité. The cost of the station, based upon the first 200,000 kilowatts, will be slightly under 600f. per kilowatt, and after the installation of Nos. 6 and 7 units, when the total power of the station will be 280,000 kilowatts, the cost per kilowatt will have decreased to 530f. This latter figure is based upon the supposition that the price of land, the cost of extensions, docks, and labour remain the same as at present, and that the construction of the station will allow the additional units to be added without any alteration to the present structure. The object which the Société aimed at was to construct a station at the pre-war price, regardless of the new and expensive apparatus employed.

On page 267 we give illustrations in Figs. 2, 3, 4 and 5 of a complete 40,000-kilowatt turbine, a turbine with the cover removed, a part of a stator for one of the alternators, and an outdoor sub-station.

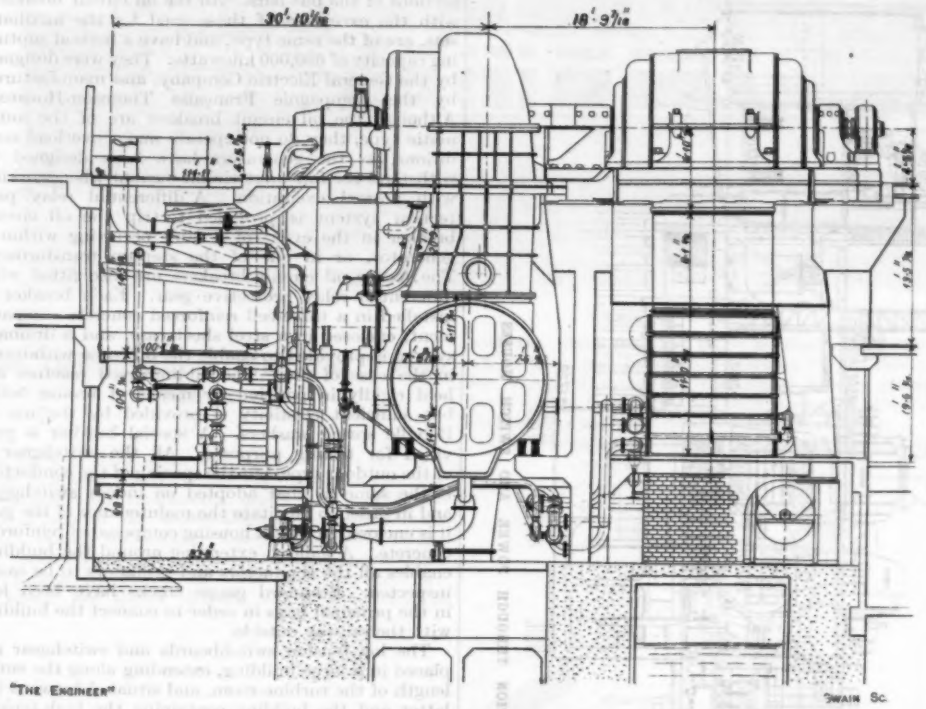


FIG. 3—A 40,000-KILOWATT TURBO-GENERATOR SET

The Story of the Ship.

THE beginnings and the development of sea power was the subject of an interesting lecture delivered by Sir Westcott Abell in the Hull City Hall, on the evening of September 11th, before the members of the British Association.

Evidence suggested, he said, that the Cretan civilisation was the first sea power in the history of man. Phœnicia, with Tyre and Sidon as its bases and Carthage as a colony, assumed the balance of power when Crete declined. Rome, although the centre of a great empire, was of small importance as a sea power. Later came the republics of Genoa and Venice, and the only other early development of importance was the Hanseatic League. Egypt was never a sea power, its ships being mainly intended for river navigation. Even the great vessels up to 420ft. in length, built in the time of Ptolemy, which carried 4000 rowers and 3000 mariners, were only large rafts, being from their description quite unsuitable for sea-going purposes. The Greek vessels were mainly of the galley type with eyes painted on the bows, a practice still followed by the Chinese. Some of these old piratical vessels were painted green to effect a measure of invisibility. The Romans, although they destroyed the Carthagenian Empire, were never shipbuilders, and never realised the value of sea transport. There was, however, a flourishing shipbuilding industry in India at the time of its conquest by Alexander the Great, and in the fifth century, when Indian adventurers colonised Java, they used vessels sculptured records of which have remained to this day. The modern Chinese ships differ only slightly from their early examples of the shipwright's art.

Turning to the records of Northern Europe, there was still preserved in the Hull Museum the famous Brigg boat, estimated to date from between 1100 and 700 B.C., and shaped out of a single tree trunk. In Norway even earlier records had been found, as well as actual remains of vessels dating from 600 to 700 B.C., of which the Gokstad ship was the most remarkable example. Norwegian sailing vessels had altered very little in design since that remote time. In England, Alfred was the first king to realise the importance of sea power. He built larger ships than those of the Danes, while Edgar, who succeeded him, was reported to have increased the Navy to 3500 vessels, with which the whole of the British Isles were patrolled. The Venetians and Genoese were expert shipbuilders, and all the Italian republics had adopted a load line similar to that marked on present-day vessels. The great Genoese carracks which were built in the first half of the sixteenth century were said to have been from 1200 to 1500 tons burthen.

The voyages of Vasco da Gama and Columbus caused a profound change in the attitude of the nations to maritime adventure, and led to attention being directed to the necessity for improvements in naval architecture to meet the greater sea risks opened up by the discovery of the New World. The invention of cannon led to further changes in design; the sides of the ship, instead of sloping outwards, having to "tumble home." In England, Henry VII. and Henry VIII. pursued a vigorous policy in regard to the Royal Navy, and the Great Harry, built in the reign of Henry VIII., suggested the type which was accepted by naval architects for many years. Henry VIII. was responsible for the formation of the Admiralty and Navy Board; he set up dockyards and inaugurated the Board of Trinity House. There was a lull in shipbuilding activities after that time until the Elizabethan period. Many new problems were faced by the designers of those days in order to enable vessels to make long voyages. Ships were sheathed with metal, capstans were introduced, rigging and arrangement of sails were more closely studied, and other improvements in detail effected. Phineas Pett, the first Master of the Shipwrights' Company, added, during the latter part of the seventeenth century, many new ideas in matters of construction. It was he who built the first three-decker in 1637, and named her the Sovereign of the Seas. It was interesting to learn, too, that during a discussion on the navigation laws which came into operation in 1666 and remained in force until 1832, Sir Josiah Child demanded the imposition of a Customs duty on articles imported in foreign ships for fear that the trade of the country would pass to the Danes, Swedes and Easterlings owing to the high cost of building ships in England as compared with the cost in those countries. It was said that in England a 300-ton vessel would cost £2400, whereas the cost of a similar ship in the countries named would be only from £1300 to £1400. In the early years of the Mediterranean shipbuilding industry the timber was always wrought green, and vessels were left on the stocks for years to season. Then came the practice of stoving, and subsequently that of steaming and boiling in kilns, and, finally, the modern practice of seasoning. The period of general highest efficiency of the old type of sailing ship was probably reached by the East Indian merchantmen both as regards speed and economy of construction. The largest clipper ever built was the Great Republic, constructed at Boston in 1853. She measured 335ft. in length and had four decks, four masts and full rigging. Fears of the Chinese tea trade falling into the hands of American clipper shipowners led to the construction of a British fleet of tea clippers, one of which, the famous Thermopylae, completed the voyage from London to Melbourne in sixty-three days. The highest recorded speed for any sailing vessel was 21 knots, which was made by the clipper James Baines, which circled the globe from Liverpool in 132 days.

The steamship came into the story just before the commencement of the nineteenth century, although the first claim to the application of steam for marine purposes went back to 1543 in Spain, and Jonathan Hull took out his patent in England in 1736. The Comet did not appear until 1811, and it was not until 1834 that Francis Pettitt Smith invented a screw-propeller, which, in conjunction with Captain Ericsson, he applied to a steam-driven vessel. Iron did not come into general use for shipbuilding until 1830, and it was not until 1843 that the first iron steamer, the Great Britain, crossed the Atlantic. The Inman ships, City of Paris and City of New York, were the first successful twin-screw vessels, and their advent marked the dropping of sail as an auxiliary to engine power. Recent developments had brought in the large high-speed liners, of which the Mauretania, Aquitania and Olympic were typical ships. The developments of this last thirty years could be illustrated by the mere statement that the original fleet of the Cunard Company could be easily stowed on the boat deck of the Aquitania.

A NEW enterprise for exploiting the water power of the Colorado River and Maipo River regions of Chile is reported. British capital to the extent of £850,000 is invested, and British engineers have reported upon the scheme, and drawn up a lay-out of plant and equipment. The first power station will consist of three units each capable of developing 10,000 horse-power, with a head of 590ft. The main canal will be nearly 9000 yards long, of which about one quarter will be in tunnel. There is water supply sufficient for two units; the other unit will remain as a spare, and will also be required to cope with the peak load at sunset. The water supply for the peak load will be taken from a local storage reservoir, decided upon in preference to a dam because of difficulties with silt. The reservoir will be fed by a small stream yielding 500 litres, or 130 cubic feet, per second, and supplementary water will be pumped to the reservoir from the forebay during periods when the peak load is off. Current will be generated at 6600 volts, 50 cycles, three-phase, and transformed up to 110,000 volts for transmission.

Railway Matters.

THE cheap fares available during the past summer are to be continued until the end of October.

THE Great Western has 3800 of its open wagons fitted with the vacuum brake. These brakes allow for the running of express goods trains at an average speed of 40 miles per hour.

REUTER'S agent at Simla cabled, under date September 5th, that the Central Railway Advisory Board had decided, by seven votes to four, in favour of State management against company management. The Government members of the Board did not vote. It was added that a Government resolution embodying the Board's decision will be brought forward at the November session in Delhi.

THE Eastern Bengal Railway management, an Exchange telegram from Calcutta says, will expend £4,500,000 on new works in the next five years. The plans include an extension to a broad gauge on the Santahar-to-Parratipur line, an extensive conversion of gas to electric lighting, the purchase of new electrically driven machines for the Kanchrapara locomotive shops, and new locomotives, bogies, and goods wagons.

AN Indian correspondent has sent to the *Railway Gazette*, as a comment on Colonel Pringle's paper on "Safety in Railway Operations," read at the London Congress of the Institute of Transport, some particulars as to continuous brakes for goods trains. Therein it is said that the equipment of the goods trains on the broad-gauge railways in India with continuous brakes is so near completion that their actual operation can only be a matter of a few months.

ELECTRIFICATION of the Montreal Harbour railway terminals, with a total length of track of 58 miles, is proceeding, and it is expected that by the end of September 42 miles will have been electrified. The remaining 16 miles will probably be completed next season, according to a statement issued by Mr. M. P. Fennell, manager of the Montreal Harbour Commission. Electric locomotives of a type especially suited for harbour work are to be purchased by the Commission.

ACCORDING to the annual block signal statistics of the Inter-State Commerce Commission, the total length of railway equipped with the block system at the end of 1921 was 102,468 miles, or 52¼ per cent. of the whole of the roads reporting to the Commission. Of this distance 39,062 miles are equipped with automatic signals—which, seeing that they secure an adequate interval between trains, are accepted as equivalent to the block system—and 63,406 miles are protected by the block system.

THE retirement is announced of Mr. F. G. Wright, chief assistant to the chief mechanical engineer, Great Western Railway, whose father was one of the original pupils of Sir Daniel Gooch. Mr. Wright was an ardent volunteer and, on the formation of the Territorial Force in 1908, raised from the Swindon shops the Fortress Company of the Royal Engineers, and, at Weymouth, the Electric Light Company. He did good service with these companies during the war, and when he retired last year he retained his rank of major.

IT is understood that a definite and satisfactory basis for the construction of border railways and bridges has been reached as a result of conferences between the New South Wales Minister for Railways and the Victorian Cabinet. The matter concerns the extension by Victoria of a number of her Murray border lines into the Riverina district of New South Wales. The most important line under consideration is understood to be that which will penetrate the Riverina to Balranald. These extensions would definitely unlock an immense area of wheat and wool country.

THE sum of Rs. 16 crores, to be spread over five years, commencing with 1922, has been allotted to the Bombay, Baroda and Central India Railway for its rehabilitation. During this period 95 new engines will be purchased, and 125 passenger vehicles and 2255 goods wagons will be added. The Railway Board has sanctioned the expenditure of Rs. 24,38,898 for replacing fourteen passenger engines by fourteen 4–6–0 D 4 type engines, and Rs. 28,01,270 for providing sixteen additional passenger tender engines 4–6–0 D 4 type during 1922–23. It has also sanctioned Rs. 6,85,413 for providing certain additional plant and machinery for the locomotive shops at Parel and Jhansi of the Great Indian Peninsular Railway.

A COMMENCEMENT is about to be made with the electrification of the Nitrate Railways Company's tracks, forming part of the principal railway system of the Province of Tarapacá, Chile. The first section to be taken in hand will be that of Iquique-La Carpas, a stretch of about 17 miles, with heavy gradients. A preliminary estimate of the cost of the work is £2,000,000. The proposed work was covered by a contract entered into between the Nitrate Railways Company and the Chilean Government as far back as July, 1921. Owing to the opposition encountered in the Chilean Congress, which resulted in a declaration of nullification of the contract, initiation of the work had to be suspended. The Nitrate Railways Company has always contended that, so far as it was concerned, the contract remained in force, and it intends to give it effect.

IN reporting on the Liverpool-street—Great Eastern—buffer stop collision of July 27th, Major Hall said that the driver admitted that the accident was due to an error of judgment on his part in delaying his final brake application until too late. There is no doubt that he was influenced in releasing his brake, after making the initial application for the stop, by his desire to pull up level with the water column so as to enable him to take water without having to unhook and draw forward. No instruction to this effect is issued by the company, but it is a natural and workmanlike course for drivers to adopt. The driver raised no question in regard to the efficiency of the brake or to the state of the rails. The latter, he said, he observed to be well sanded as he entered the platform. Retardation appears to have been normal, and there was no suggestion that any of the wheels picked up. His evidence was frank and straightforward, and he made no attempt to evade his responsibility for the accident.

Notes and Memoranda.

A QUAINT combination of modern and ancient forms of transport is to be tried in Colombo, where some of the native bullock carts are to be fitted with rubber tires, with the dual object of reducing the tractive effort necessary and checking the destruction of the road surface.

STEEL masts, instead of wooden masts, which are difficult to obtain, and often unsatisfactory, are recommended by *Steel Structures* for use in connection with amateurs' wireless installations. A simple tubular mast 30ft. or 40ft. high is usually suitable. This type is built up of several lengths of galvanised solid-drawn tube, each length being slightly less in diameter than the one immediately below it. A cross-bar may be inserted in the upper end to provide a ready means of attaching the span wires, and rings secured around one of the sockets permit of the easy attachment of guy ropes. For larger installations lattice girder masts are available, and are as easily erected.

THE extensions which were begun in March last at the German wireless station of Nauen are reported to be now well in hand, and it is expected that by the beginning of next year the work will be far enough advanced to permit permanent communication to be established with the new Argentine station at Monte Grande, near Buenos Aires. Four of the existing masts at Nauen, which are over 390ft. in height, have been removed and replaced by a series of seven towers 688ft. in height, which provide four additional antennæ circuits, each of which is served by a high-frequency alternator. The new antennæ will be used for American, Asiatic, African, and European services, and for distant stations, such as the South American station above mentioned, two or more antennæ may be used in combination with each other. The transmitting installation has been improved and enlarged, and the system of earthing connections has been extended.

IN an article appearing in the *Brown-Boveri Review* on 1500-volt rotary converters for direct-current railways, it is stated that the result of tests made with the first rotary converter for a pressure of 1650 volts demonstrate clearly that it is quite possible to build reliable and efficient 50-cycle rotary converters for pressures of 1500 volts and more for outputs as large as are required in sub-stations of main line railways. On account of their low first cost, and their ability to recuperate the energy liberated on railways which employ regenerative braking, and to influence the three-phase system by phase compensation, they are, in many cases, the most suitable machines for converting alternating current into direct current. Seven rotary converters for the Midi Railway of France are being built in the Brown-Boveri works at Munchenstein (Switzerland). One of the machines was completed and ready for testing in four months after the first drawings were made.

IN an article on "Fuel Economy in Steam Power Plants," appearing in the September issue of the *Beama Journal*, Mr. John B. C. Kershaw says the power station of the Duquesne Electric Light Company, at Colfax, Pennsylvania, is equipped with boilers which possess 20,876 square feet of heating surface; and the new power-house of the Ford Motor Works at River Rouge, Michigan, has beaten this with boilers possessing 26,470 square feet, or nearly double that of the boilers at the Stuart-street (Manchester) station. The furnace alone of each one of these enormous boilers measures 23ft. by 25ft. by 55ft. in height, and will accommodate eight Ford motors side by side on its floor. It is probable that this represents the extreme limit of development in the size of steam power units, under existing conditions; and that the pendulum will now swing back in the direction of smaller and more easily controlled boilers and furnaces for steam generation.

THE official returns of the French coal trade show that during the first six months of 1922 imports of coal to France totalled 12,365,000 tons, as against 8,774,000 tons in the corresponding half of 1921, and 10,718,000 tons in 1920. Imports from Great Britain in the first six months of 1922 are given as 6,923,000 tons, as against 2,206,000 tons last year, and 7,255,000 tons in 1920. The coal exports during the first half of 1922 totalled 1,541,033 tons, as against 1,728,843 tons in the first six months in 1921. During the first half of 1922 France imported 2,445,310 tons of coke, as against 1,701,590 tons last year, and 2,012,114 tons in 1920, while her coke exports in the first halves of the three years were 229,981 tons, 88,219 tons and 22,115 tons respectively. Of briquettes, she imported from January to June this year 775,596 tons, as against 480,973 tons and 816,346 tons respectively in 1921 and 1920. Exports were 74,880 tons, 83,164 tons, and 47,376 tons respectively in the three half years.

ACCORDING to the *Electrical Review*, a simple but very useful piece of apparatus has been made by Mr. E. Humphries for use on small direct-current supply systems. It consists of a double head-gear telephone receiver and induction coil, the primary of the coil being connected in series with a radiator lamp taking a current of about 1 ampère. A flexible cord with an adaptor is used to connect up to any lampholder, thus lighting up the lamp through the primary winding. The receiver is connected across the ends of the secondary winding. Mr. Humphries, who is in charge of a small generating station, has found this apparatus invaluable for listening in on any part of the system with a view to detecting any unusual disturbance, such, for example, as a motor with bad commutation, faulty brush gear, or bad motor starter. Every motor has its own particular note, and one running badly can be distinctly heard above the rest. The slipping of a belt is easily heard owing to the erratic rise and fall of the current. The starting and stopping of a motor also conveys useful information to the listener. A single-stroke pump driven by a belt was fixed up during the war about a mile away from the supply station to supply water to a war hospital. It had to be attended to by the supply company's staff, and was left running all day. The pump worked at 60 strokes per minute, and any irregularity in the running was easily heard on the telephone. Many weird sounds and happenings too numerous to mention can be heard—a loud crack tells of a short circuit, and can be heard anywhere in the room. This apparatus is chiefly used at Mr. Humphries' home, which is some distance from the station, and should prove interesting to other engineers.

Miscellanea.

THE Bill authorising the construction of a bridge across Sydney Harbour and works in connection with this undertaking, at a cost of £5,000,000, was read for the first time on the 7th inst. in the Australian Legislative Assembly.

THE Commonwealth Steel Products Works at Newcastle (N.S.W.) have secured large Government orders, including axles and tires for the Queensland Railways, and dredger parts for the South Australian Harbour Board. It is declared that under the new wages award the company is able to compete with overseas firms.

IN the course of a motor tour through Zululand, General Smuts, speaking at Eshowe, said that he had come to inspect Kosi Bay to see what could be done for the East Transvaal coalfields, whose outlet had hitherto been handicapped by the unsatisfactory handling of the export coal at Delagoa Bay. Progress, he added, must now be made with the scheme of creating another port in British territory, and investigations had already been begun.

IT is reported from Bombay that the United Provinces Board of Health has announced its decision to allot funds for experimenting with woodstave pipes, instead of cast iron or steel pipes, for the Board's water supply and drainage schemes. Extensive use is made of such pipes in Canada and the United States. At present it is not known whether the Board intends to import pipes of this description from America or to manufacture the staves from Himalayan spruce.

THE growth in working expenses of the electric tramways at Gerthe and Hoerde, Westphalia, threatens to bring these lines to a complete standstill. Wages and raw materials have reached such a level that it is thought to be no longer possible further to raise the fares to meet the higher working expenses, the wages of the tramway employees alone having now advanced to 37½ marks per hour at Gerthe. The owners of the Hoerde district lines have already applied for permission to discontinue the services.

THE monthly return of the National Federation of Iron and Steel Manufacturers shows that the production of pig iron in August amounted to 411,700 tons, or 12,600 tons more than in July. The furnaces in blast at the end of the month numbered 126, or nine more than at the end of July. The production included 120,200 tons of hematite, 137,400 tons of basic, 102,200 tons of foundry, and 22,900 tons of forge. The production of steel ingots and castings amounted to 520,800 tons, or 47,700 tons more than in July, but still only 69 per cent. of the average monthly production in 1920.

THE South African Government has entered into an agreement with the Marconi Company for the erection of a high-power station capable of direct communication with the United Kingdom of the thermionic valve type of approximately twice the power of the new Saint Assise station near Paris. It is anticipated that the station will be completed within eighteen months. The station is to be used as an integral part of the Imperial wireless system, priority being given, as far as is consistent with the efficient working of the station, to communications with other stations of this system.

FOR the purpose of providing more port facilities to ensure the satisfactory development of the foreign trade of Japan, it was decided at a recent meeting of the National Harbour Improvement Commission to initiate a large improvement plan. According to information from official sources, the work will be spread over ten years' starting from the fiscal year 1923. It is authoritatively stated that a sum of 6,583,200 yen, for the first instalment of the project, will be included in the budget of 1923. Improvements will be made at the ports of Yokohama, Kobe, Osaka, Aomori, Shiogama, Funchawa, Niigata, Shimidzu, Nagoya, Yokkaichi, Takamatsu, Shimonoseki, Moji, Nagasaki, Tottori, Tsuruga and Nawa.

THE Hull (Canada) Electric Company has acquired the Paugan Falls on the Gatineau River, together with the necessary property adjacent thereto, for the purpose of hydro-electric development on a large scale. A dam 125ft. high will be constructed, which will create a reservoir 10 square miles in area. The ultimate output contemplated is 150,000 horse-power, and the cost is estimated at ten million dollars. The falls are situated 35 miles from Ottawa, which is at present dependent upon the Chaudière Falls for its supply of 50,000 horse-power of electric energy. The city of Hull, already an industrial centre of importance, lies on the north bank of the Ottawa River, opposite the city of Ottawa, in the province of Quebec.

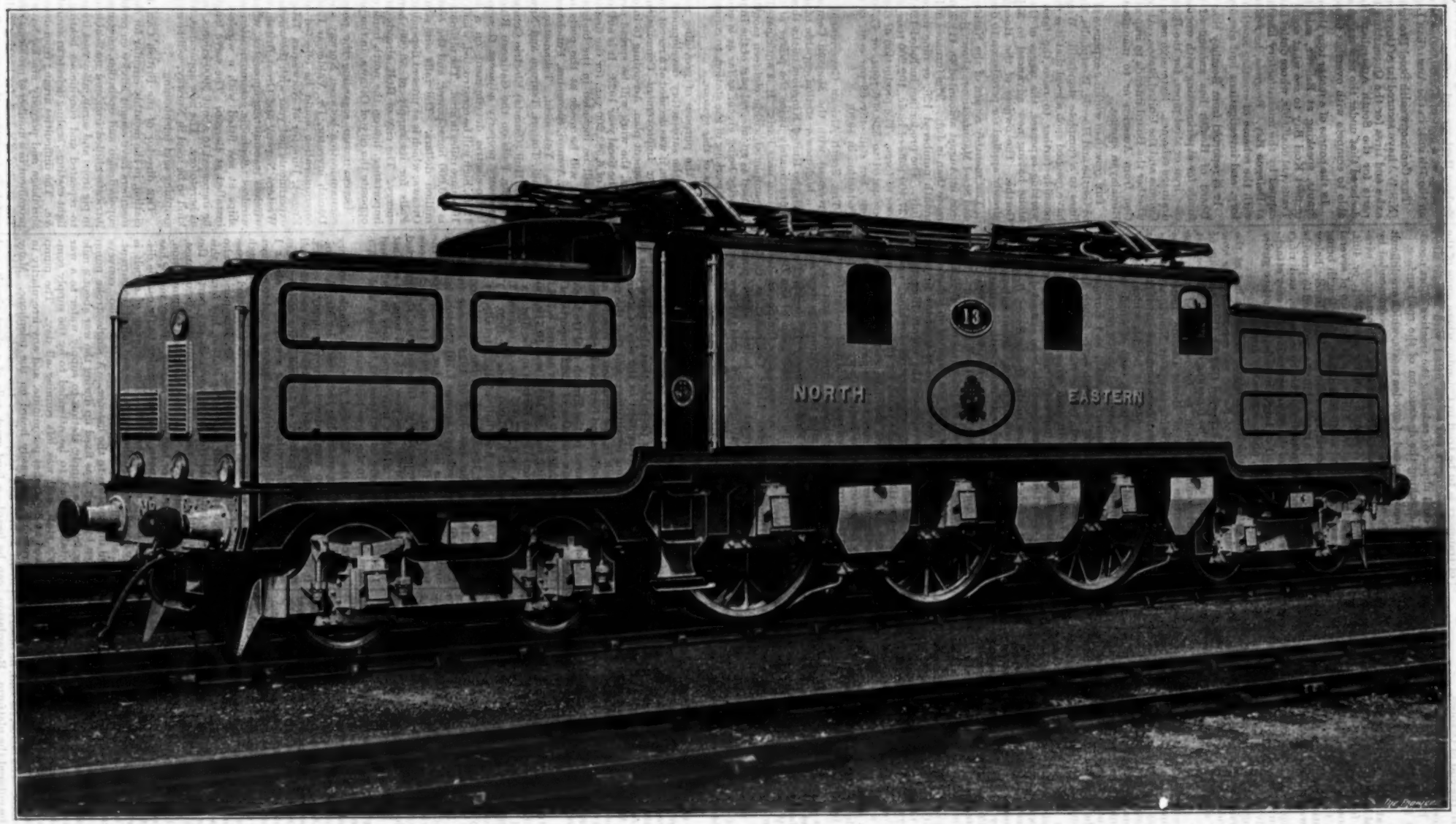
INTERVIEWED regarding the possibility of telephonic communication between Norway and Great Britain, the Danish inventor, Dr. Valdemar Poulsen, said that such communication could be effected at any moment. M. Engset, Director of Norwegian Telegraphs, declares that experiments last year with the wireless telephone between Western Norway and Great Britain were a success. New wireless transmitting apparatus, which will make possible wireless telephonic communication with liners and other ships at sea fitted with a wireless telephone, is being installed at Bergen. The wave length will consequently be increased to about 3000 kiloms. instead of 900 kiloms. as heretofore. The new apparatus, which is the first of its kind to be used in Norway, will be employed both for telegraphing and telephoning.

THE director of the British Cast Iron Research Association, in the monthly circular for September, states that members have sought advice on problems connected with cupola design and operation, mixtures for heavy cylinders, intricate chilled iron and malleable castings, irregularity in pig irons and scrap, alloy cast irons for castings subject to repeated and continuous heating, sand mixtures for light castings, scaling defects in annealed cast iron articles, &c. The difficulties arising from defective design, causing shrinkage and porosity cracks, have again been signally prominent in a number of problems submitted by members. The erosion of vessels for heating and melting non-ferrous metals is occupying the serious attention of the Association, and aid has been sought in suggesting suitable mixtures for this service. Work is now proceeding in the more serious researches on motor car cylinders, moulding sands, refractories, and draws and shrinkage.

NORTH-EASTERN RAILWAY—EXPRESS PASSENGER ELECTRIC LOCOMOTIVE

SIR VINCENT RAVEN, M. INST. C.E., DARLINGTON, ENGINEER

(*For description see page 280*)



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THE ENGINEER.

SEPTEMBER 15, 1922.

The Cruising Endurance of Submarines.

AMONG the popular misconceptions with regard to naval material that prevailed before the war, none was more deeply rooted than the notion that a submarine boat could remain at sea only for a few days at a time, and therefore could not be employed in any operation which involved a prolonged absence from its base. This was one of the principal arguments with which Sir Percy Scott's critics sought to refute the sweeping claims he had made on behalf of the submarine only a few weeks before the outbreak of the Great War. It was put forward, not merely by civilian writers, but by several naval officers of high rank, and in view of this authoritative opinion it is not surprising that the general public came to regard the submarine as being useful only for coastal operations. Events soon showed, however, that the sea-going range of these vessels had been grossly underestimated. In the first month of the war German U boats were met with several hundred miles from their nearest base; early in 1915 they were encountered off the coast of Ireland, and by the spring of that year one boat had arrived at Constantinople after a voyage of 3450 nautical miles from Wilhelmshaven. Meanwhile small British submarines built in Canada had crossed the Atlantic under their own power, and the E 11, of 675 tons, had made a trip in the Sea of Marmora—that is, in enemy waters—lasting thirty-one days. Then, a year later, came the cruise of the German U 53 to the United States coast and back, a voyage of at least 7000 miles, which was accomplished without replenishing the supply of fuel. It may be said, therefore, that the cruising endurance of submarines proved to be about ten times greater than pre-war forecasts had indicated. There is still some uncertainty as to the maximum period of time which a submarine spent continuously at sea during the war. The British boats on the Atlantic patrol frequently made voyages of well over one month's duration, while according to German accounts the first "Untersee-Kreuzer," the U 139, made one cruise lasting six weeks.

Interest in this question of submarine endurance has now been revived by the remarkable performance of a French boat, the Victor Réveille, which was recently ordered to carry out a test for determining how long she could remain at sea. Leaving Cherbourg at the beginning of July, she arrived at Toulon on August 31st, after an uninterrupted voyage of sixty days. This, so far as is known, constitutes the longest voyage which has been made by a submarine up to the present date, though it need hardly be said that peace conditions are far more favourable for such a test than those which obtain in war. The Victor Réveille was formerly the U 79, and is one of the many ex-German submarines now under the French flag. Completed at Hamburg in 1916, she belonged to a group of ten boats which were specially designed for mine-laying, and one of which sowed the mines that sank H.M.S. Hampshire, with Lord Kitchener on board. The performance of the Victor Réveille is the more noteworthy in view of her modest dimensions. On the surface she displaces only 755 tons, increased to 833 tons when submerged. Her length overall is 186ft. 4in., the breadth 19ft. 10in., and the draught 15ft. 1in. She is therefore less than two-thirds as long as a modern destroyer and some 10ft. narrower in beam. The propelling machinery consists of two sets of Diesel four-cycle six-cylinder engines, developing 900 brake horse-power, which gives the boat a surface speed of 10.6 knots. For submerged propulsion the electric motors develop 800 brake horse-power for 8 knots. In his paper on German submarines, Mr. A. W. Johns, R.C.N.C., said that the class to which this boat belongs differs from all the ordinary U boats in having internal main ballast tanks. They have a pressure hull of large diameter—16.4ft., as against 13.5ft. in U 161—and small external saddle tanks, which, instead of carrying water ballast, carry oil fuel. The two main ballast tanks are internal, the larger extending under the mine room and up the sides of the motor room, while the other is under the engine-room and partly up the sides of that room. With a full load of fuel, amounting to 87 tons, the nominal range of the Victor Réveille at an economical speed of 7 knots is 7800 miles. It is not yet known what distance she actually covered in the course of her sixty days' voyage, but it is evident that had a speed of 7 knots been maintained throughout, the total run would be 10,080 miles, or 2280 more than she is supposed to be capable of making on one load of fuel. In point of fact, the radii of all the German boats with which our experts have had experience have proved to be substantially larger than the official German estimates, and there is more than a suspicion that their actual endurance was purposely minimised for obvious military reasons. That the submarine possesses a much wider radius of action than any surface warship of equivalent size is now well known, but it is doubtful whether the full extent of her advantage in this respect is commonly realised. She derives it mainly, of course, from her internal combustion engines, which at low power are very economical in fuel consumption, while the structural arrangement of the hull is well adapted to the carriage of a large supply of oil in proportion to the displacement. Official data published since the war show that great cruising endurance was aimed at in the design of all German submarine types. In the U 29, a typical U boat of 675 tons displacement, the endurance at an economical speed of 8 knots was 9800 miles. In the U 43, of 725 tons, it increased to 11,250; in the "Untersee-Kreuzer" Nos. 139 and 142 it was respectively 18,000 miles at 8 knots and 20,000 at 6 knots. Still more remarkable were the corresponding figures for the smaller types; the UB 18, of only 272 tons, was credited with an endurance of 7000 miles at 5 knots; the UB 48, of 516 tons, with 9000 miles at 6 knots; and the UC 16, of 410 tons, with 8700 miles at 7 knots. These are boats whose limited dimensions would seem to put them in the category of coastal submarines, yet they were nevertheless capable of voyaging for many thousands of miles. The longest-range submarines built in Germany appear to have been the Deutschland and her six sister boats, originally designed as submersible cargo ships, but afterwards converted into fighting craft. Although of only 1510 tons displacement, their fuel supply was sufficient for a continuous run of 25,000 miles at a speed of 5½ knots. However, when estimating the sea endurance of small vessels, whether of the surface or submersible type, it is necessary to take other factors besides the mechanical into consideration.

That a boat such as the UB 18 could really make an uninterrupted voyage of 7000 miles may well be doubted. Owing to the cramped accommodation below and above deck, the difficulty of ventilating the narrow interior spaces packed with machinery, the noise of the Diesel engines, and the violent motion of the boat in rough weather, the health of the crew would inevitably begin to suffer after a few weeks at sea. In other words, the human element would be liable to become exhausted long before the mechanical element had reached its limit. In time of war the conditions of service on board would, of course, be infinitely more trying; there would be a constant strain on the nerves of

the men when they were at sea, especially in enemy waters, and therefore had to spend most of their time under hatches. The actual radius of any type of submarine in war time would therefore depend primarily on the mental and physical stamina of the complement, which implies that it cannot be fixed with any degree of precision. But as submarines increase in size, enabling better living quarters to be provided and setting free more space on deck for exercise and recreation, the conditions of service tend to become more tolerable, and there is consequently less likelihood of a breakdown occurring in the health or *morale* of the *personnel*. There is no visible reason why a very large ocean-going submarine should not be able to remain at sea as long as her fuel holds out, without imposing any superhuman strain on the *personnel*. On the other hand, if dimensions are increased beyond a certain limit the submarine becomes difficult to manœuvre below the surface and requires to be navigated with extreme care in all but the deepest waters. For this reason every navy will no doubt continue to build boats of moderate size—say, up to 1000 tons—for general service, while at the same time developing the large submersible cruiser type for special overseas operations. This division of types seems, in fact, to have been adopted in the United States, France and Japan, following the example set by Germany during the war. Although the prospect of a long period of peace has naturally slowed down the development of the submarine boat, steady progress is still being maintained, and there are boats now under construction abroad which appear to be little, if at all, inferior to the German submersible cruisers in respect of sea endurance. The advent of submarines capable of crossing and recrossing the Pacific Ocean with a margin of 10,000 miles to spare promises to introduce a new and complicating factor into naval strategy.

The Economic Basis of Wages.

The discovery of some practical way of establishing a basis for wages is of as much importance in this country as in France, where the problem is proving a source of trouble in all branches of industry. Wages were inflated at a time when the ordinary standards for adjusting them could not be applied, and as conditions remain unstable it is found impossible to fix upon a definite basis. There is scarcely a branch of the manufacturing trades in which it has not become absolutely necessary to bring down wages to a level in accordance with the growing factor of foreign competition. The French constructive engineer finds that his production costs have been steadily increasing with additional charges, dear raw material and high railway freights. The industry is not centralised as it is in some other countries, and raw material has often to be worked up into the finished product at considerable distances from the sources of supply. The relatively high cost of production has placed French manufacturers in the position of not being able to compete for foreign trade, and they are complaining that in their own market they are being undersold by the British and the Belgians—the latter because they can get much more work done for the wages paid.

All the schemes now being put in hand for bringing down production costs with the aid of cheap electrical energy and low water-borne freights can only take effect in the course of years. Meanwhile, there is no hope of effecting economies except by a reduction in wages, which the men are resisting on principle; they are prepared apparently to go to extreme lengths to support the claim that employers have no right to impose sacrifices on them. Nevertheless, employers offer every facility for an inspection of their books to prove that they are not making profits and are, in many cases, sustaining serious losses. Their selling prices are regulated by the prices of foreign competitors, the only margin being the import duties which are often absorbed by the special terms that foreign manufacturers are inclined to offer for export business. In some cases the situation has become so unsatisfactory that makers are obliged to consider the desirability of definitely closing their works if the men refuse to accept lower wages. That is the state of things in the Havre district, and it is also the situation of the chain makers in the Nord, who declare that the home business has declined in alarming proportions through slackness of work at the shipyards and through the competition of huge quantities of chains from the British Army stocks. In the colliery district the miners admit that the companies are not making profits, but they claim that the companies must bear the burden in times of bad trade as they made big profits when prices were high without the miners being accorded corresponding advantages. The uncompromising attitude taken up by the men, or rather by their unions, has compelled employers to go more deeply into the economic side of the problem and try to convince the men that the whole future lies in providing the ways and means of cheapening the cost of living and thereby allowing workers to enjoy the same, and even greater, advantages with lower wages. An adjustment of wages on a production basis would be satisfactory to French manufacturers if they could be sure of the men fulfilling their part of the contract. As a matter of fact, the production in the majority of cases has fallen off with increased wages, and as all efforts at securing a greater output have failed, the only hope lies in reducing wages in proportion to the output, which is obviously only possible—if strife is to be prevented—by inaugurating a policy that will ensure a reduction in the cost of living.

In France the problem is complicated by the fact that a policy is being pursued of restricting as much as possible the expenditure of money on products from abroad. Every effort is being made to produce in the country everything required for home consumption. The agricultural and other industries are therefore highly protected, and a certain degree of antagonism to the agricultural community, which is accused of making unduly large profits out of foodstuffs of all kinds, has arisen amongst the industrial centres. It is certain, however, that there is a considerable margin between the prices obtained by the grower and the prices at which produce is sold to the consumer, and there is no doubt that a more liberal foreign trade policy, which would check the operations of speculators and intermediaries without seriously affecting the interest of growers, would bring down the cost of living to a very appreciable extent. The manufacturing industries are to this extent trammelled by a highly protected agricultural industry, and a more liberal trade policy, which must be advantageous to all industries alike, would settle the industrial problem by enabling workers to live equally well with lower wages. This is the main economic fact which employers are now seeking to impress upon the men. If the workers are to secure regular and profitable employment they must use their influence in the direction of modifying a policy which can only have the effect of keeping prices at an artificial level. The high cost of living is invariably put forward by the men to justify the maintenance of the existing scale of wages, but as the cost is kept up artificially the standard is too high to be accepted for the adjustment of wages. If employers succeed in their efforts to convince workers that a reduction in living costs constitutes the only economic basis for wages there will be some hope that a policy for removing restrictions on foreign trade may be adopted with the effect of relieving the situation of the manufacturing industries.

Literature.

The Heat Treatment of Soft and Medium Steels. By F. Giolitti, translated by E. E. Thum and D. G. Vernaci. London: The McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 30s. net.

It may be doubted whether an individual is competent to translate a technical book unless he be competent to write a presentable book on the same subject. As much care and responsibility are called for in the one effort as in the other. A capable translator should not disfigure the original; with a genius for such work his translation might be equally accurate, clearer and more readable than the original. One wonders whether Omar's "Rubaiyat" is as excellent as Fitzgerald's translation, whether Fabre really wrote such charming books about insects as de Mattos' translations have made known to English-speaking people, and if Maeterlinck's "Life of a Bee" is as good as Sūtro's English version of it.

A recent review of an English translation of a French book on metallography emphasises the fact that a successful translator should employ the idiom of the second language, not only as regards the idiom of speech but also—a point of the greatest importance in technical books—the idiom of phraseology of the subject itself. Only by so doing does the translation become really intelligible to the reader who is only familiar with the technology of the subject as found in his own country.

Regarded from this point of view, the present translation is far from successful. It is apparently an almost literal translation, with the result that much of the text would hardly be regarded as good English. Such phrases, for example, as "the next to last column," "by a succeeding too-slow cooling," "the just indicated fact," may be literal translations of very good Italian, but they are certainly clumsy English. Apart altogether from such "literal" defects, however, a great part of the book consists of involved sentences, the meaning of which is not readily apparent without very careful reading. One of the most important features of a technical book should be the unambiguity of its language. Its object should be to set out the theories, facts and whatever may be the theme in language the meaning of which is perfectly clear and obvious. The phraseology should certainly be correct and well formed, but a technical or scientific work is not the place for indulging in flights of rhetoric. The fact that one of the translators is an editor of a technical journal published in the United States would lead one to expect a translation in English, probably somewhat terse but essentially readable. On the contrary, however, this feature is lacking to an irritating degree.

Apart from the examples of doubtful English given above, there are numerous passages which suggest that the translators have only a limited acquaintance with the phraseology of iron and steel metallurgy. For example, "a prismatic test piece 20 mm. square, tested under static flexure," can hardly be regarded as an ordinary description of a bend test.

Dr. Giolitti has the reputation in this country of being one of the most prominent Italian metallurgists. He has been actively associated with what may be termed both the academical and the practical sides of steel manufacture. It would have been expected that a book from his pen, while paying due regard to the theoretical basis of metallographic work, would combine this with the practical application of these theories to commercial work, drawn from his experience while associated with the firm of Ansaldo. The first half of the book is devoted to a highly theoretical study of the crystallisation and diffusion of the constituents of steel. At the outset it may be wondered for what type of reader the author intended this part. It is certainly only understandable by those well trained in physical chemistry; to the ordinary individual connected with works heat-treatment it would be almost unintelligible. Dealing with this part, however, the most striking thing is the emphasis laid on the solubility of carbon in alpha iron. In the ordinary equilibrium diagram this solubility is regarded as practically nil, or at any rate so low as to be almost negligible. It is certainly a fact that it cannot have a greater value than of the order of .05 per cent., since steels with .06 to .10 per cent. carbon show quite evident amounts of pearlite. Giolitti, however, lays great stress on the solubility in alpha iron (though he gives no numerical figures for its value), and draws highly complex diagrams founded on it. To such an extent is this almost infinitesimal range of analysis emphasised that when dealing with special steels the only diagram (Fig. 19) refers to this hypothetical, or at any rate exceedingly narrow range of composition, in which the structure when cold consists of a solid solution of carbon in alpha iron.

In the later part of the book examples are given of the application of the author's theories to practice. Many of the experiments give results which could be anticipated without the use of the author's complicated diagrams. In other cases it is exceedingly difficult to fit in the author's theory with his practice. For example, in the early part of the book a great deal of attention is devoted to the use of "homogeneity" treatments, as they are called, which presumably are treatments carried out at temperatures such as will bring the steel into a homogeneous condition and therefore above the Ac3 point of the steel. Yet further on in the book there are numerous instances of the use of temperatures which are distinctly below this point; for example, 850 deg. Cent. is not sufficiently high for a steel containing .09 per cent. carbon, and .47 per cent. manganese; nor is 750 deg. Cent. an adequate temperature for refining a casting containing .47 per cent. carbon.

There is a great deal of value to be found in the book by a very careful and critical study; probably one of the most important parts is that dealing with the influence of non-metallic impurities on the properties of castings and forged or rolled steels, a subject to a great extent neglected by many writers on metallography. It is regrettable that this valuable data will probably not have the attention it deserves at the hands of English readers owing largely to the unfortunate manner of its presentation.

Electric Railway Traction. By F. W. Carter. London: Edward Arnold and Co. Price 25s. net.

A more suitable title for this book than that which the author has given it would be "Direct-current Electric Traction." Although the existence of alternating-current electric railways has not been overlooked, the volume can only be recommended to those who have made up their minds that the single-phase system is not worth bothering about. Following the policy of a fair number of other writers on the subject, Mr. Carter does his best in the early part of his book to show that single-phase electrification has little to recommend it, and says that Mr. H. M. Hobart did much in the early days to propagate sound views on the subject. As a matter of fact, however, the views expressed by Mr. Hobart in the days to which the author alludes appear, in the light of modern expe-

rience, little short of absurd. In 1908 Mr. Hobart predicted that in ten years' time the single-phase system would be exposed at the expense of the capitalists and the system discredited. Various other striking statements were made by this authority about that time, and in view of what has since happened it is strange to find Mr. Carter referring to these utterances. Whilst the high-tension direct-current system has, of course, made considerable progress, the amount of alternating-current work that has been carried out cannot by any means be ignored. Indeed, according to Sir Philip Dawson, the single-phase system is at present the most extensively used system in connection with locomotives.

"Continental engineers," states Mr. Carter, "explain the unfavourable results obtained with the single-phase system in America as being due to the general use of a frequency of 25 cycles per second, as required for the successful operation of the single-phase motor." It would be interesting to know, however, in what respect these railways are unsatisfactory. Incidentally we may remind Mr. Carter that successful 25-cycle single-phase lines are in operation on the Continent, and trains are worked at the same frequency in this country. To get a fair idea of what has really happened in America we cannot do better than refer again to the recent remarks of Sir Philip Dawson at a meeting of the Institution of Electrical Engineers. "In the United States," Sir Philip explained, "there are some 386 miles of line working on the low-tension direct-current system, on which 123 electric locomotives are operating, and nearly 1100 miles of line working on the high-tension direct-current system are running 90 locomotives; whilst 634 miles of line electrified with alternating-current employ 224 locomotives." Sir Philip also explained that in Europe there were 1664 miles of single-phase lines.

We need not deal here with all the author has to say about the disadvantages of single-phase electrification, but we cannot refrain from pointing out that his assertion that the maintenance of single-phase equipments is double that of direct-current equipments is now well known to be wholly untrue. Years ago, when these equipments were nothing like as perfect as they are now, there were perhaps good grounds for believing that their upkeep was costly; but there are now few engineers who do not realise that the maintenance costs have been greatly reduced as the result of modern improvements. Dealing with this matter in connection with the report on the electrification of French railways,* Mr. George Gibbs, who is recognised to be one of the foremost authorities on the subject, said the Commission which was appointed to deal with the matter seemed to have been dominated by telephone and telegraph experts and to have been greatly influenced by the reports of high cost of maintenance, which was stated to be at least double that of direct current, "a conclusion which was absurd."

Apart, however, from the author's unwarranted attack on the single-phase system, the book has a good deal to recommend it. Mr. Carter's association with direct-current electric traction extends over many years, and there is no doubt that the information he has brought together concerning electric locomotives, railway motors, control gear, distribution systems, power equipment and mechanics will be studied and appreciated by many who are associated with electric railway work. The book contains many drawings and diagrams of connections, curves, calculations, &c., which ought to be of value to railway men. The automatic sub-station is dealt with at considerable length; but the author gives it as his opinion that the time when the attended sub-station can be dispensed with has not yet arrived. As far as direct-current practice is concerned, the book is quite good; but we should advise those who are seeking reliable information on the rival system to study some other volume.

Electric Ship Propulsion. By Commander S. M. ROBINSON, U.S.A.N. Simmons-Boardman Publishing Company, New York. 30s. net.

IN view of the progress that has been made in America in connection with the electric propulsion of ships, this book by Commander Robinson is acceptable, for as far as we know no other up-to-date book on the subject is available. It is true that Mr. H. M. Hobart produced a volume on electric ships some years back, but since that time much practical work has been undertaken and valuable experience has been accumulated. After considering the conditions under which electric propulsion is justifiable, the author deals with the question of whether direct or alternating current should be used, and comes to the conclusion that the latter is preferable on vessels that are fitted with turbines, whilst for Diesel engine ships direct current is shown to be the best.

Following those considerations there are chapters on propeller characteristics, characteristics of alternating-current motors and generators for ship propulsion, special characteristics of turbines and governors for electric propulsion, ventilation, heaters and fire extinguishers, switchboards, interlocks and controls, wire cables, insulators and insulation, and exciters and other auxiliaries. The remainder of the volume is to a large extent descriptive, and particulars are given of the equipments which have been fitted to a fair number of American ships, such as the Jupiter, the New Mexico, the California, Maryland and West Virginia, the Tennessee, Colorado and the Washington, United States battle-cruisers, and battleships Nos. 49–54, and the Wulsty Castle, which is fitted with a Ljüngstrom turbine.

Finally, the author discusses the Diesel engine drive, which he considers opens up great possibilities for electric transmission, because the electric motor eliminates the necessity for starting the engine under load, greatly facilitates reversal, and enables the machinery to be arranged in the vessel to the best advantage. It is possible, it is explained, to place the generators on the upper deck, whilst the motors can be placed well aft, so that the cargo space is in no way interfered with. The grounds on which the author advocates direct current for Diesel-engine ships are that it enables speed regulation to be obtained in a simple fashion, facilitates reversal, and the switching arrangements are more simple than those used with alternating current.

Altogether the volume contains a great amount of useful information on the electric propulsion of ships, but one or two of the wiring diagrams leave much to be desired. A diagram showing the wiring on the United States ss. California, for example, will, we are afraid, prove very puzzling to the reader, and it is a great pity that an endeavour was not made to simplify it or print it on a much larger scale. Apart altogether from the difficulty of following the connections, the publication of these small and intricate diagrams is very liable to lead shipowners and others who are not versed in electrical affairs to believe that electric propulsion is extremely complicated and next to impossible to understand. In general, however, the book has been pretty well prepared and ought to meet with a fair amount of appreciation from those who are interested in the subject.

* See THE ENGINEER, July 29th, 1921, page 123.

British Association.

No. I.

SECTION G.

STRENGTH OF RAILWAY BRIDGES.

THE opening session of the Engineering section of the British Association meeting in Hull was devoted to a discussion on the strength of railway bridges, having regard to the heavier loads and higher speeds of modern trains as compared with those in service when many of the bridges were constructed.

The decision to bring this question up for discussion arose out of the declared intention of the Ministry of Transport to impose more drastic rules following a report which was made last year to the Advisory Committee which has had under consideration a revision of the Board of Trade requirements in regard to the opening of railways. It will be recalled that this report, which was signed by Major A. Mount, one of the inspecting officers, was the outcome of a decision reached by a sub-committee of which the late Sir James Ball, chief engineer of the London, Brighton and South Coast Railway, and Mr. W. A. Fraser, chief engineer of the North British Railway, were members. It was recognised that there was divergence of practice among railway companies in dealing with the impact effect of traffic on bridges. Some railways vary the present permissible working stress of 6½ tons per square inch in accordance with the span or with a range of stress formula, while a minority make no allowance. The adoption of the Pencoyd formula was contemplated, but it was recognised that the view was held by engineers that the formula provides inadequately for small, and excessively for large spans. The late Sir James Ball suggested that a limited number of experiments should be conducted by the Ministry of Transport to verify this impression or to give support to any alternative recommendation. It was arranged that tests should be carried out with the Fereday-Palmer stress recorder on the London and North-Western, North-Eastern, Great Western and South-Eastern and Chatham Railways. Twenty bridges were tested, and 181 runs made, giving in all 362 records. The bridges selected were of steel construction, and as far as possible typical of British practice. They varied in span from 15ft. to 146ft. 8in., and included types of unballasted, ballasted and jack arch floorings. The test train consisted of one or two typical two-cylinder passenger type locomotives and a dynamometer or other coach. Average maximum speeds were worked to, but in one case 84 miles an hour was recorded. The report stated that the experiments were not carried out with the idea of exploring the more theoretical side of the impact problem, but rather of ascertaining whether for practical purposes a formula could be recommended which would provide for all normal increases to stresses due to the live load. The tests were read as showing that stresses of secondary character often of high value are normal and unavoidable in floor systems. Normal stresses would, it was assumed in the report, be covered in the impact allowance, but not extraordinary stresses, and where the exigencies of design do not permit the avoidance of such stresses, the intention of the Ministry is apparently to require the use of additional metal to ensure that the proposed working stress of 8 tons per square inch shall not be exceeded. This proposal has been received with some astonishment in railway circles.

Mr. J. S. Wilson opened the discussion. He said that the various aspects of the problem of the strength of railway bridges could be brought to the notice of the meeting in the shortest time by referring to the famous case of the Torksey Bridge. When an extension of the Manchester, Sheffield and Lincolnshire Railway, between Retford and Lincoln, was being inspected in 1849, preparatory to its opening to the public, Torksey Bridge across the Trent was tested by the representative of the Railway Commissioners. The bridge was designed to give two river openings of 130ft. clear, and consisted of a platform wide enough to carry a double line of way, supported by wrought iron plate girders of the Fairbairn tubular type. It was built by John Fowler. In the test two locomotives with their tenders were put at the centre of each line on one of the spans. Their total weight of 148 tons gave a deflection of 1½in. It was considered excessive, exception was taken to some parts of the workmanship, and the inspector did not feel sufficient confidence in the bridge to recommend the Commissioners to authorise its use. What appeared to be very arbitrary action on the part of the Railway Commissioners caused great consternation among the bridge engineers of the day. Fowler protested against 5 tons per square inch being considered the greatest stress permissible with safety, and mentioned that experiment had shown that 8 tons was perfectly safe, and that no good authority had recommended less. However, the opening of the railway was postponed. Fowler eventually convinced the Commissioners by further experiments that the girders acted as continuous girders, and he maintained that under those circumstances the stresses were actually below 5 tons per square inch. He also offered to reduce slightly the weight of ballast on the flooring. The Commissioners' inspector finally agreed to pass the bridge as safe with the reduced ballasting. That bridge, which was so nearly condemned, was still in service. For forty-six years, from 1850 to 1896, it remained as originally erected, carrying all traffic satisfactorily. In 1896, in order to assist the cross girders, which must have been the weakest part of the structure, a longitudinal girder was added between the two lines of way, so that during the seventy-two years since its erection, in spite of the increase in axle loads from year to year, whatever the stresses may have been, the old girders had withstood them.

MINISTRY OF TRANSPORT NEW RULES.

Mr. A. C. Cookson (Great Western Railway), who made a contribution to the discussion jointly with Mr. J. S. Nicholas, said that the Ministry of Transport had had under consideration recently the revision of the old Board of Trade rules for the opening of railways, and its proposals concerning the strength of bridges were of great interest to all designers of such structures. At the present moment the only regulation as to strength was that, under the heaviest loads, a stress of 6½ tons per square inch must not be exceeded. It was now proposed to make an allowance for "impact effect" at various spans. At zero span the percentage of the load to be added as "impact effect" was 133, and the limiting working stress suggested was 8 tons per square inch. In the opinion of many engineers experienced in the design and maintenance of railway bridge work the suggested percentage was unnecessarily high. He and Mr. Nicholas had been engaged on that class of work for many years, and since the proposed rules were suggested had given special attention to the subject, and had made surveys of, and extensometer tests on, certain old structures which, judged by the Ministry of Transport standards, were below strength, but which, judged by measured stresses and the evidence of present condition, were perfectly satisfactory for retention in service. A very interesting feature of the results of the tests carried out by the Ministry, and others carried out by the authors, was that there appeared to be a hitherto unsuspected reserve of strength in nearly all bridge work. In view of that fact, it was not surprising that the proposals of the Ministry, which would in effect make all new bridge work much heavier and more costly than that being designed at present, were being resisted by many railway engineers. He suggested, as a result of the inquiries and experience of himself and Mr. Nicholas, a rule in which the "all live load" stress would be 5 tons per square inch and the "all dead load" stress 7½ tons per square inch; the stress on an individual member of any bridge being got from the particular proportions of dead and live load. They also suggested that the ultimate resistance of built-up members of bridge work should be the subject of inquiry by engineers and research workers in joint action. Their view was that much secondary work, such as stiffeners to plate girders and overhead bracing to braced structures, was much overdone. They urged that the Ministry should delay putting into force any new rule at least until the conclusions of the Indian Railway Bridge Committee were published. That body, as was well known, was engaged on a most interesting series of experiments as to live load effect, which were being conducted by engineers highly specialised in that particular class of work. Present-day railway engineers were fully alive to the importance of the problem of heavier loads and higher

speeds, and could, he thought, be relied upon to construct their bridges with an ample margin of safety and to preserve the remarkable degree of immunity from disaster which had characterised the history of railway bridge work in this country.

ECONOMY IN BRIDGE DESIGN.

Mr. Conrad Gribble (North-Eastern Railway) said the guiding motive in bridge design was a desire for economy in first cost and in subsequent maintenance and a striving after a more accurately designed structure in which there were no weak links. The necessity for stronger bridges which would safely carry modern locomotives and the experience gained in a century of fighting against corrosion of metallic structures, had compelled engineers to consider very carefully what were the best materials to employ in order to provide not only the strongest, but also the most durable, form of bridge. The problems confronting railway engineers in the Old and New World respectively were rather different. In this country, for instance, engineers were not so greatly concerned with the design of long span bridges carrying new railways over wide rivers and estuaries, nor as yet with the replacement of long spans. The greater part of the railway bridge engineer's time was spent in the calculation of the factor of safety of existing structures of moderate span, and the renewal of such as were ascertained to be deficient in strength. The time had come when a great number of wrought iron bridges constructed during the latter half of the nineteenth century were becoming obsolete either on account of their original strength being inadequate to face modern conditions or because corrosion had taken too heavy a toll of their strength. Thirty years ago the use of wrought iron began to cease on the introduction of mild steel, and the newer material had not been superseded to any appreciable extent, despite the invention of high-tension alloys, and the fact that for the smaller bridges at any rate, concrete was being employed to an increasing degree either as an encasement for steel girders or in the form of reinforced concrete. The use of expensive alloys, such as nickel, chrome or manganese steels for ordinary bridges was not at present justified, since the lightness of the structure was not the governing factor, and, in fact, many engineers appeared to aim, at present, at durability rather than lightness. The most recent invention of the metallurgists, stainless steel, was more attractive to the majority of bridge engineers, and it would be the most valuable improvement from the point of view of railway engineers which one could at present visualise, provided that its strength was at least equal to that of mild steel, and that it had the necessary toughness and malleability. Concrete could not easily be applied to large structures owing to its great weight, but there were great hopes that the cement gun would prove a useful appliance for providing a thin and impermeable coating to girder work. It was claimed that concrete so formed was of such a dense nature that a thin coat was effective. It was being used in the United States of America on a very large steel arch at present being built in a district notoriously detrimental to steelwork, where the weight of a poured encasement would have been out of the question. He rather regretted the use of the term "secondary stresses," as there seemed to be a widespread idea that such stresses were of secondary importance, whereas it was obvious that all stresses must be of equal importance if they occurred simultaneously, and the only stresses which might be ignored were those which did not occur at the same time as those which produced maximum stress, and thus did not contribute to nor relieve the maximum stress. The only way by which it was probable that accurate methods of design could be attained was by experiments on existing girders, and they should not be directed merely at ascertaining the actual stresses which occur during the passage of locomotives over the bridge, but should also be employed to discover the manner in which, and the point at which, the bridge failed. The difficulty of conducting breaking or crippling tests of large bridges was considerable, but he would like to suggest that as numerous bridges were removed by various railway companies every year, some of them might, with considerable advantage, be reassembled and loaded to breaking point, if a suitable plant could be obtained. The applied load would be merely static and not moving, but that method of testing would be perfectly satisfactory, since separate tests of bridges *in situ* could be carried out to ascertain the ratio between maximum stresses under static and speed conditions. The question of rivets was a vexed one; we were probably putting far too many into new bridges. He suggested a series of experiments on riveted plate girders to ascertain the precise proportion of rivet area which would bring about direct failure of flange or buckling of web. The results would be of the greatest value to bridge engineers. To those who were carrying out tests on completed structures he would lay stress on the need of obtaining (*a*) a measure of the ultimate resistance of the assembled structure and of its component parts respectively; (*b*) a measure of the stresses produced by different types or arrangements of loads whether static stresses, impact stresses, secondary stresses or temperature stresses. To measure the precise factor of safety of a particular bridge, it was necessary to know not merely the actual stresses under speed conditions, but also the maximum load which the bridge would carry without failure. No experiments had been carried out to ascertain the latter figure, and therefore some of the discussions regarding the exact amount of the impact effect in bridges were rather artificial.

One effect of the impending amalgamations would be that the chief engineer of a group of railways would have seriously to consider the adoption of a consistent system on the grounds of economy; since having decided upon a reasonable factor of safety for new bridges as well as for existing ones, any increase in this factor would involve a waste of money, and any decrease an increase of risk, neither of which could be justified. Every means should therefore be adopted to ascertain the real resisting capacity of existing types of bridges, the problem being, of course, rendered more urgent by the probable increased interchange of locomotives and rolling stock.

Mr. A. C. Gardner (Great Central Railway) agreed with Messrs. Cookson and Nicholas. His experience as an engineer responsible for bridge maintenance confirmed the statement made in their paper. There was to-day too much tendency to theorise on bridge design. He did not like the word "impact" in connection with the stresses imposed in railway service; it was merely a case of making allowance for the live load stress. Calculations should be regarded merely as an aid to judgment, as there were many indeterminate factors which could only be allowed for as the result of practical experience. It was sometimes overlooked to what extent rail bearers or sleepers, ballast and rails added to the strength of a bridge. It was quite common knowledge that many old bridges were to-day carrying loads far in excess of those for which they had been designed.

Mr. R. Pawley (late Hull and Barnsley Railway) expressed his interest in the history of the Torksey viaduct. One of the great difficulties from the maintenance point of view in the case of old bridges was the inaccessibility of parts of old girders; but that defect was not found in modern bridges. The question of impact was admittedly difficult. The railway engineer regarded impact as dynamic and not static, and it was quite probable that in many cases the ultimate effect might not be transmitted to the main girders. A homely illustration of the way in which the effect might be deadened was given by the man who at a fair offered to allow a huge stone to be broken on his chest, knowing that he would not be injured.

Professor F. C. Lea offered a criticism of the attitude of the average professional man towards calculation, in which he was inclined to put more faith than was the mathematician. It was necessary to find out exactly what was meant in bridge work by "factors of safety," which it had been well said were rather factors of ignorance. Designers often failed to realise into what errors they fell in calculating bending moments. He agreed that in railway bridges the main girders were protected by the rails and the ballasting. The greatest deflection did not take place when the heaviest element of the load, the locomotive, passed over the bridge. It was never a case of measuring actual wheel loads; the periodicity of the load must be taken into account and allowance made for resonance. It was desirable to conduct experiments with built-up girders to determine the stress which actually occurred, and having obtained values for the distribution of stress under statical load, proceed then to obtain figures for rolling loads and try to fix the relation between the two sets of figures. At present engineers relied to a large extent on guesswork.

Mr. C. E. Stromeyer said that as a boiler engineer he had never been able to understand why so many rows of rivets were used in bridge work, and he could not help thinking that a considerable saving in labour and material might be effected. Factors of safety were, in his opinion, too high, and could be reduced without risk.

Professor Andrew Robertson expressed his suspicions of the instruments used in the Ministry of Transport tests, which might give misleading results in those particular cases. It was a matter of regret that the Ministry of Transport, whose policy was definitely challenged by railway engineers, was not represented at the meeting. He was glad that attenton had been directed to possible resonance effects. That was a mathematical question, and it would be a good thing if the Ministry could secure the services of one or two tame mathematicians and set them to work on the problem. The tests carried out by Mr. Wilson and Professor Haigh on specimens with holes were of interest, but it was not the same thing as a test on riveted joints. The question of concentration of stress was an extremely difficult one, but it ought to be investigated, and he believed that light could be thrown on a baffling question by a research on fatigue. The end at which to aim was to increase knowledge to the point where the factor of safety could be reduced.

Mr. Nicholas said that under present circumstances railway companies should not be called upon to spend money unnecessarily. Railway engineers were convinced that bridges possessed a large reserve of strength, but the Ministry of Transport was opposed to any credit being taken for that reserve. The railway man took advantage of Sir Benjamin Baker's modification of the beam formula. Corrosion was the main trouble of the maintenance engineer. The whole subject was ripe for fresh inquiry, but railway companies protested against being hampered by rules which were hurriedly framed.

Mr. R. W. Weston regarded the survival of so many old bridges as a most satisfactory feature of the situation, as they supplied valuable data for the design of new bridges. Railways were monopolistic enterprises, and both railway engineers and Government officials concerned with railways were apt to play for safety, as the penalty of making a mistake was a very heavy one.

INFLUENCE OF RIVET HOLES.

The effect of rivet holes on the strength and endurance of steel structures was discussed in a joint contribution by Mr. J. S. Wilson and Professor B. P. Haigh.

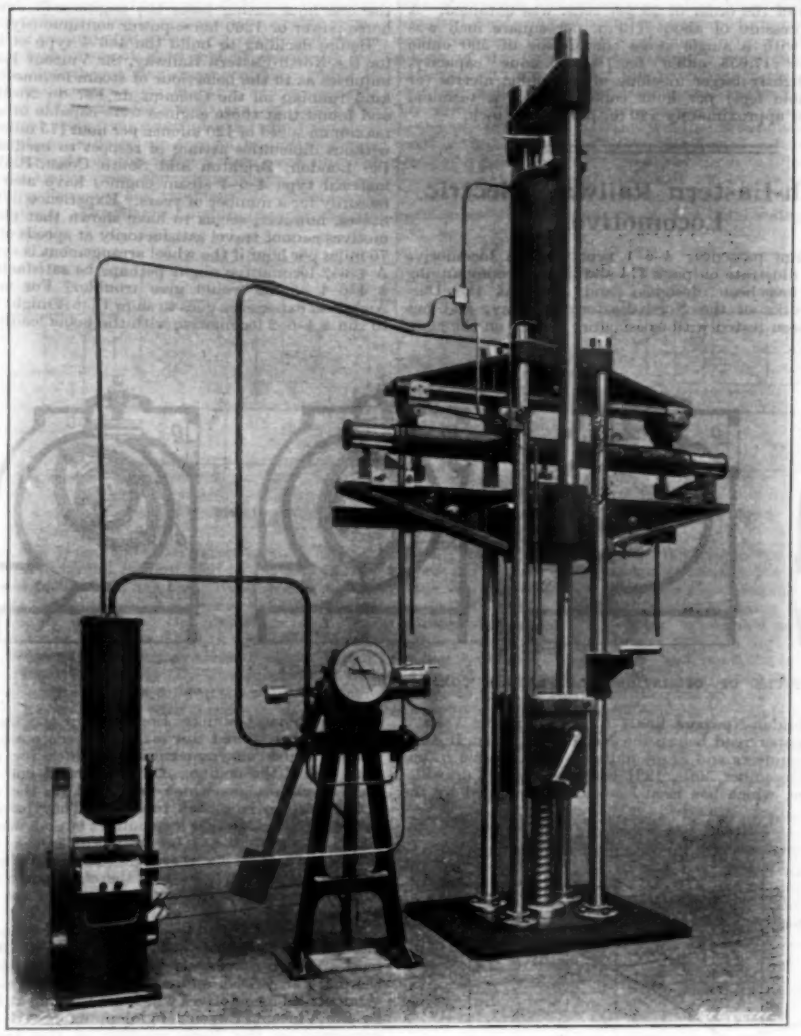
It was pointed out that in steel structures the members are joined together with rivets and built up of plates, angles and other rolled sections riveted together along their whole lengths. Members in tension were obviously weakened by the numerous rivet holes that pierced the sections, but the ratios of reduction were not at present well established. The problem was of great importance to bridge and other structural engineers, and was of scientific interest on account of its bearing on the theory of stress distribution in relation to the "fatigue" of metal. In the opinion of the authors, current bridge designing practice had been influenced to an undue degree by conclusions drawn directly or indirectly from the results of "static" tests in which typical members had been tested to destruction under steady loads. Although experience had shown that the breakages that occurred in practice were due to cracks produced by stresses varying with the loads on the structure, experiments had not hitherto been available to show the action of such stresses on structural details. It appeared to the authors that designers, lacking the support of such data from experimental sources, had neglected lessons that might have been drawn from practical experience and had yielded to a tendency to exaggerate the dangers of "live loads." The authors had carried out experiments on model plates 1¼in. by ⅛in. with and without perforations, those dimensions having been adopted to reproduce the proportions of a typical plate in a bridge member, 9in. by ⅞in., with holes to suit ⅞in. rivets. The tests were carried out in a Haigh alternating stress fatigue testing machine adjusted to apply stresses pulsating 2000 times per minute. The metal used in the tests was a mild steel with a comparatively low yield point; and the authors considered that the choice of metal was important, since the mode of failure was appreciably influenced by the ratio between the yield point and the ultimate tensile strength. The experiments showed (1) that in mild steels such as were used in practice, fatigue would not occur under pulsating stresses unless those reversed in direction, acting as push as well as pull, at least, locally where the stresses were modified by the influence of perforations; (2) that in steels of higher tensile strength fatigue might occur, although the stresses acted always in one direction and kept well below the yield point; (3) that fillets and perforations produced locally the conditions required to promote fatigue in mild steels; (4) that the dangerous influence of a hole, in promoting fatigue in a mild steel plate, was less than had been believed; (5) that pierced plates, in failing from fatigue, cracked at right angles to the line of the applied pull, and not necessarily across the narrowest sections between the holes. The results of the tests are analysed in tables accompanying the paper, and tentative conclusions are given for design; but it is pointed out that additional tests are required in certain directions. It is concluded, however, that the experiments endorse the view—based on practical experience—that the danger of fatigue under pulsating stresses is decidedly less than often has been supposed.

THE Illinois Central Railroad has, by means of newspaper advertising, under the caption "The 1921 Dollar," been taking the public into its confidence as to what each form of income contributes per dollar and in what way each dollar is spent. We thus learn that goods traffic brought in 71.71 cents and passenger traffic 16.98 cents. Maintenance of track took 15.65 cents, maintenance of equipment 18.94 cents, operation 26.69 cents, fuel 7.50 cents, interest on bonds and other charges 6.85 cents, taxes 5.54 cents, dividends 4.48 cents, and reserves 1.60 cents.

IT will be remembered that on September 26th last year a gang of platelayers at Stapleton Road, Great Western Railway, stepped out of the way of one train on to another running road, and six of the eight men were killed and one seriously injured. At Wilmcote, on the same railway, last spring, a gang of four men had no look-out man, and failed to notice the approach of a light engine and were all run over and killed. As a result of these accidents the Great Western Company has added to its excellent "Safety First" work by issuing a small book, "Safety on the Permanent Way," to every member of the permanent way staff and to all artisans who have to work on the track. This little pamphlet tells plainly by picture and story the dangers the men run and what they must do to avoid them. In view of the fact that out of 228 servants killed by trains last year, 65, or 29 per cent., were platelayers, it would be a good thing if other companies followed the Great Western's excellent example.

UNIVERSAL 100-TON TESTING MACHINE

A. J. AMSLER AND CO., SCHAFFHAUSEN, ENGINEERS



Deflection Testing of Locomotive Axles.

IN many of the recent lectures to the local branches of the Institution of Locomotive Engineers considerable attention has been paid to the methods of conducting acceptance tests of steel parts for locomotive construction. Few subjects have caused so much discussion as that of materials testing, and it is therefore of great interest to have the opinion of such well-known experts as, for example, Sir Henry Fowler, that the tensile test, although the oldest, is still the most reliable. Like most others, however, it has its limitations when taken alone, and when only the ultimate tensile strength is found without a simple and reliable determination of the elastic limit, the value of this test is somewhat deficient from the point of view of the designer. The nature of the final fracture often provides useful information to the alert inspector, but the elongation and contraction of area only give a doubtful estimate of the toughness of the material.

A much more suitable guide to this elusive property is provided by the bending test, either of the selected test piece to the customary U form, to show how far the metal may be deformed without fracture, or of a tire or an axle complete. As it is not every form of testing machine which can be readily adapted to perform these as well as other tests, such as shearing and hardness tests, with simplicity and accuracy, a brief description of one of the newest forms of universal testing machine for performing all these acceptance tests on railway material, such as hooks, chains, axles, couplings, &c., as used by some of the large continental shops may be instructive.

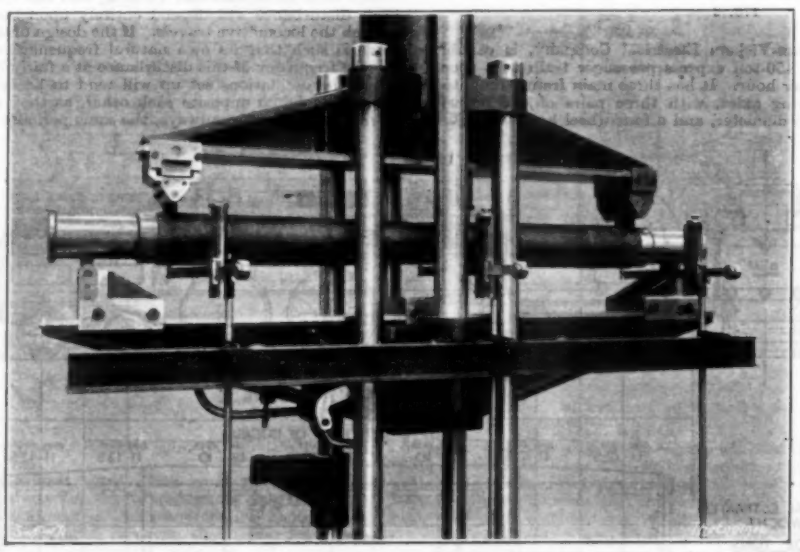


FIG. 1—BENDING TEST ON A LOCOMOTIVE AXLE

The machine in question is shown above, and has a capacity of 100 tons. It stands 15ft. high, and occupies the small floor space of 4ft. by 3ft. Being without the customary levers and balance weights, it is comparatively light, weighing only 10,000 lb., and simply stands on the floor of the test house, over a shallow pit to accommodate the adjusting screw for the lower gripping head. The load is applied by an oil-operated ram working in a cylinder sufficiently tight to obviate the use of any packing. The slight oil percolation eliminates friction, and allows the pressure set up to be used for measuring the load exerted, without separate weighing apparatus. The pressure oil delivered from the motor-driven three-plunger pump enters the press cylinder and raises the ram, thus lifting the crosshead and the suspending bars of the movable cradle, which acts as a bending beam. When this cradle meets with the resistance offered by the tensile, compressive or bending test piece, an increasing pressure is set up in the oil system, and this pressure is measured at every instant by the pendulum dynamometer. This dynamometer has in its lower part a small piston, the area of which bears a definite ratio to the area of the ram, and which acts through yokes and hanging bars to operate a short block lever rotating a shaft or axis, set in ball bearings, and fixed to the heavy pendulum. The deflection of the pendulum from its vertical position provides the reaction to the load pressure, and enables it to be read exactly from an indicating pointer travelling over the graduated dial. At the same time an autographic stress-strain diagram is recorded. By suspending the pendulum from different points, the sensitiveness of the machine can be instantly changed from 100 tons to 50, 20 or 10 tons, even during the progress of a test, which is entirely controlled by the operator working the two valves on the dynamometer frame.

In making transverse bending test on axles, &c., up to 7ft. in length, the bending may either be performed by a single central bolster set in the crown of the machine, or, more nearly in conformity with actual working conditions, by means of a double fulcrum upper beam, as shown in Fig. 1. The maximum span of these upper supports is 5½ft. When making this test, it is desirable to determine the deflection at different loads. To accomplish this measurement, sensitive feelers are used, and are attached to a datum bar or H beam fixed to the cradle of the machine, but not subjected to any loading. In Fig. 1 all three feelers are shown making contact with the underside of the axle. The small counterpoise weights at the other end of the 12in. arms keep them constantly in contact. Each feeler is provided with a pointer which moves over a graduated arc when the test piece is bent, a total deflection of 2 mm. being registered in graduations reading to the nearest $^1/_{100}$ mm. When the deflection exceeds 2 mm., the whole feeler can be moved on its supporting rod by means of a micrometer screw, which also enables the travel of the feeler to be read to the nearest $^1/_{100}$ mm. The total deflection observable is 80 mm. (say, 3in.), and the supporting rods allow the feeler arms to be moved up or down as much as 60 cm. (say, 24in.). The clips to the datum bar are such that they allow the supporting rods to be adjusted to any desired position along the beam.

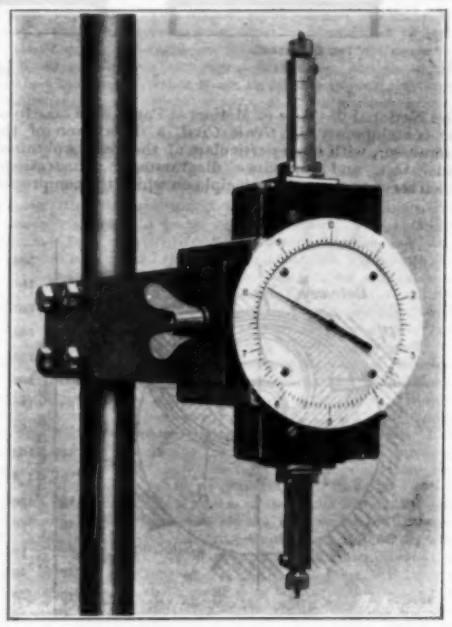


FIG. 2—IMPROVED FORM OF INDICATOR

A completely new form of deflection indicator has recently been developed for the same purpose. The indicator consists of three feelers which touch the test beam at selected points either above or below it, and the amount of bending relatively to the horizontal datum bar is transmitted to the three dials, on which it can be read from a distance. Each of the feelers—see Fig. 2—is carried on a supporting arm which can be adjusted up or down a column, movable at will along the comparison beam, and clamped to it anywhere on its length. Each feeler consists of a box in which the feeler rod can move vertically between guide pulleys. This rod engages by friction a little pulley which also forms the spindle of the pointer turning in front of the dial. One turn of the pointer corresponds to a 10 mm. displacement of the feeler rod, which can travel 10 cm. (say, 4in.), the integral number of centimetres being read off from the scale on the rod itself. There are 200 graduations on the dial, so that one-twentieth of a millimetre is indicated, although the distance between the successive graduations is large enough to enable $^1/_{200}$ mm. to be easily estimated. If the feeler touches the test beam on its upper side, the

contact is effected by the weight of the feeler rod. When placed below the bar, the feeler is kept in contact with it by a small counterpoise, heavier than the feeler. The extreme end of the feeler rod does not touch the test beam directly, but does so through a small point which can deviate slightly in case the point of contact does not move exactly in the direction of the feeler rod. Once the feelers are placed in contact with the bar, it is not necessary to touch them again. The container box, which weighs only 7 lb., can be very easily taken off the supporting arm, being detached by unscrewing a wing nut, so that it is not necessary to disconnect the supporting rods from the comparison bar when the feelers are not being used.

This testing machine and its accessories are made by the firm of Alfred J. Amsler and Co., of Schaffhausen, Switzerland.

The Planche Rotary Compressor.

A NEW rotary compressor of the volumetric type, which embodies some interesting features in its design, has been constructed by M. R. Planche, of Villefranche-sur-Saône, and tested at the laboratory of the Conservatoire National des Arts et Métiers at Paris. We take from our contemporary *Le Génie Civil*, a description of the compressor, with some particulars of the results obtained under test, and reproduce diagrammatic illustrations, which serve to show the principle on which the compressor works. Fig. 2 shows the rotor in its dead centre position and serves to indicate the position of the rotor relative to the suction and delivery ports in the main body of the casing. Motion is imparted to the rotor by means of the pinion T which is carried on the main crank shaft; this shaft is supported in main bearings affixed to the outer casings, and is furnished with two fly-wheels for balancing. The teeth on the pinion T engage with the internally cut teeth on gear wheel S which moves in the path of an excentric around the crank shaft centre O. The rotor R is mounted on the outer circumference of the gear wheel S, and it is furnished at its extremities with two sliding pallets P_1 and P_2; these are pressed out by means of springs, and serve to maintain the necessary tightness between the ends of the rotor and the outer casing of the compressor. The main body of the rotor is formed of laminated steel strips which conform in shape to the circular casing. The disposition of the suction and delivery ports and the successive positions of the rotor throughout one complete cycle of operations is shown in Figs. 1 to 5 respectively.

The air or gas to be compressed enters the inlet chamber A and fills the space B, where it is compressed by the revolving rotor into the space C, and passes through the light disc delivery valve into the outlet chamber D. The small amount of air—some 5 per cent. of the total volume of the cylinder—which remains in the clearance space C then re-expands and does work on the piston, the position of the suction port being such that when the rotor uncovers this port the pressure of the expanding air is so low that it does not interfere with the air which is being entrained by the other side of the rotor. The lubrication is effected by means of a mechanical lubricator, which delivers the oil to the compressor under pressure. The distribution of the oil in the compressors is greatly assisted by centrifugal action, and as it remains in contact with the various surfaces for some length of time, the consumption of lubricating oil is, we understand, comparatively small. The compressor is cooled by means of a water jacket which surrounds the cylinder on all faces. An automatic pressure regulator is fitted and adjustments for varying outputs are possible.

The curves reproduced in Fig. 3 show the results obtained in the trials carried out at the Paris laboratory of the Conservatoire National des Arts et Métiers. The compressor tested had a capacity of 300 cubic metres (or about 10,590 cubic feet) per hour, and when run as an air pump a vacuum of the order of 98 per cent. was obtained. A delivery pressure of about 113 lb. per square inch was obtained with a single stage compressor of 500 cubic metres (or 17,658 cubic feet) per hour capacity, while a slightly larger machine of 600 cubic metres (or 21,189 cubic feet) per hour capacity gave a terminal pressure of approximately 120 lb. per square inch.

FIGS. 1 TO 5—CYCLE OF OPERATIONS OF PLANCHE COMPRESSOR

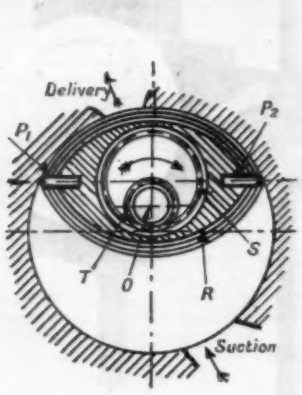


FIG. 2

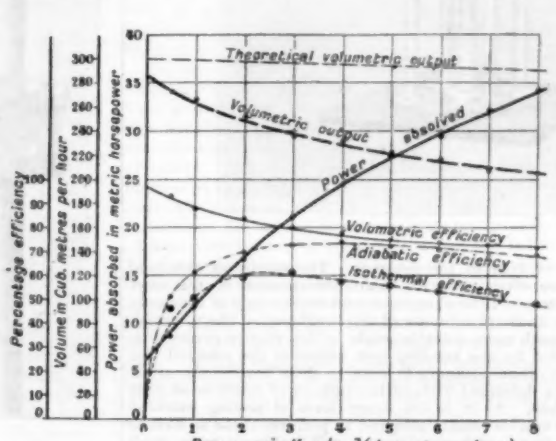


FIG. 3

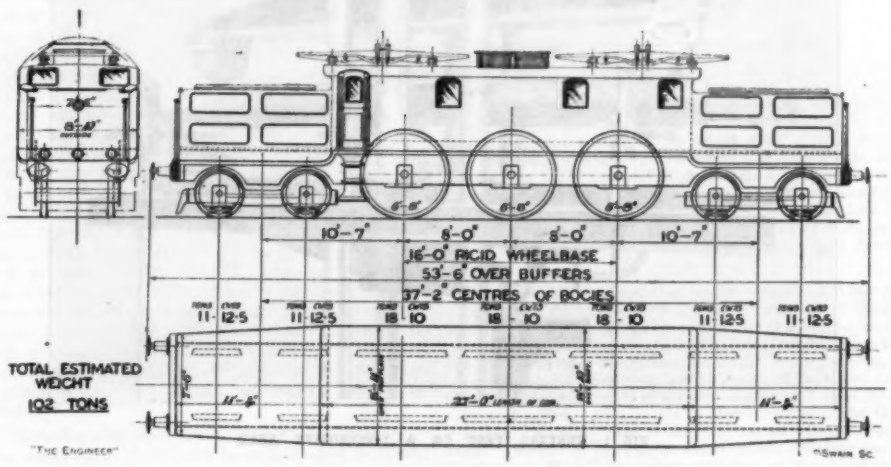
North-Eastern Railway Electric Locomotive.

THE large passenger 4–6–4 type electric locomotive which we illustrate on page 274 and in the accompanying drawing, has been designed and built at the Darlington works of the North-Eastern Railway, and has recently been tested with satisfactory results on the company's Shildon-Newport line. As stated in Sir Vincent Raven's paper read before the North-East Coast Institution of Engineers and Shipbuilders, and published in our issue of December 30th, 1921 with a two-page drawing, the engine, which has been electrically equipped by the Metropolitan-Vickers Electrical Company, is capable of hauling a 450-ton express passenger train at a speed of 65 miles per hour. It has three main frames mounted on three driving axles, with three pairs of driving wheels 6ft. 8in. in diameter, and a four-wheel bogie at each end. The cab and sloping ends are rigidly fixed to the main frames and are provided with the necessary supporting members for carrying the auxiliary and control equipment. Pantographs mounted on the roof at each end of the centre compartment collect the current from the overhead trolley wire. The main traction motors, which are twin-armature machines, are rigidly fixed to the main frame of the locomotive, and transmit the torque to a gear wheel mounted on a hollow shaft or quill. All the high-tension apparatus is placed in one of the sloping ends of the engine, whilst at the other end there is an electric boiler for the supply of steam for heating the train. On the one hour rating basis the engine will develop 1800 horse-power or 1260 horse-power continuously.

Before deciding to build the 4–6–4 type of locomotive for the North-Eastern Railway, Sir Vincent Raven made inquiries as to the behaviour of steam locomotives of this kind running on the Chemins de Fer du Nord Railway, and found that those engines were capable of attaining a maximum speed of 120 kiloms. per hour (75 miles per hour) without difficulties arising in respect to oscillations. On the London, Brighton and South Coast Railway symmetrical type 4–6–4 steam engines have also run satisfactorily for a number of years. Experience in the United States, however, seems to have shown that electric locomotives cannot travel satisfactorily at speeds of, say, 70 to 75 miles per hour if the wheel arrangement is symmetrical. A 4–6–2 locomotive might perhaps be satisfactory, whilst a 4–6–4 engine would give trouble. For such speeds American experience goes to show that it might be possible to run a 4–6–2 locomotive with the bogie leading, but not with the bogie trailing. Engineers in the United States who have considered this matter advocate a construction which, whilst unsymmetrical, provides for a bogie at each end of the engine, and recommend one or other of the various designs which are based on the articulation of two locomotives back to back. They have suggested at one time and another locomotives having wheel arrangements 4–6–0 + 0–6–4 because whilst the locomotive, considered as a whole, is symmetrical, each part is unsymmetrical, and each part will therefore run satisfactorily without setting up violent oscillations of the locomotive as a whole.

It is not easy to find any satisfactory explanation of the difficulties which have been experienced in this direction in the United States, especially in view of the fact that there are on British and continental railways a number of symmetrical locomotives which are running at high speeds. In Sir Vincent Raven's opinion, expressed in a paper presented at the Paris meeting of the Institution of Mechanical Engineers,* oscillations can only arise from the fact that there is a periodic disturbance tending to set up horizontal oscillations, and the frequency of this disturbance is the same as that of the natural frequency of the locomotive in oscillating in a horizontal plane.

There is no doubt a good deal to be learnt about symmetrically arranged locomotives running at high speeds, but Sir Vincent Raven has suggested that one possible cause of the trouble experienced in the United States and from which European railways seem to be free is that on practically all railways in America the rail joints are staggered, whereas on British railways the joints are opposite to each other. The staggered joints in the United States must, it is considered, set up a periodic disturbing force both horizontal and vertical, and the frequency of this disturbance will depend entirely upon the speed at which the locomotive travels. If the design of the locomotive is such that its own natural frequency corresponds to the frequency of this disturbance at a fairly high speed, then the oscillations set up will tend to become violent. With rail joints opposite each other, as they are on the British and French railways, the same periodic disturbing force cannot, it is considered, be set up, and any oscillation of the locomotive which might arise from any local cause would tend to die out immediately.



NORTH EASTERN RAILWAY—ELECTRIC LOCOMOTIVE

* See THE ENGINEER, June 23rd, 1922.

Thermionic Valves on Public Supply Systems.

THE chief disadvantage of the ordinary thermionic valve is that it requires an accumulator and dry cells to work it, and the possibility of drawing the necessary currents from ordinary supply systems is a matter which is claiming a fair amount of attention. A paper read before the American Institution of Electrical Engineers by Mr. P. D. Lowell, describes a five-stage amplifier which is said to work satisfactorily on 60-cycle supply systems without the use of batteries for the filament or plate. The first arrangement tested consisted of one radio frequency amplification stage, a detector, and an audio frequency stage. The filaments of the three valves were supplied by a step-down transformer, the primary being connected to 110-volt 60-cycle mains and the filaments to the 6-volt secondary winding. The filament lighting transformer is

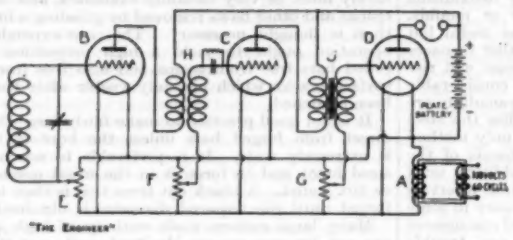


FIG. 1

shown at A in Fig. 1, and the three valves at B, C, and D. The amplifier input circuit is connected to the grid of the tube B and to the slides of a balancing resistance E, which has a value of 200 ohms, and is connected across the wires which supply current to the filaments. A radio-frequency transformer is shown at H, a second balancing resistance at F, an audio-frequency transformer at J, and another balancing resistance at G. The function of the balancing resistances E, F, G is to keep the normal voltage of the grids at a steady value with respect to the average voltage of the electrical mid-point of the filament, and thus eliminate the hum which variations of the grid voltage

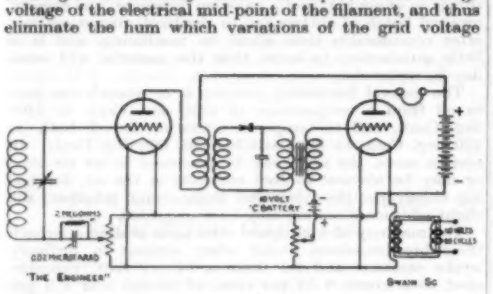


FIG. 4

would otherwise produce, all the resistances being adjusted until the hum is eliminated.

Tests with this arrangement showed, however, that these balancing resistances would not by any means completely eliminate the hum, but the employment of a crystal detector in place of the thermionic valve detector reduced the hum very considerably. The connections for this arrangement are shown in Fig. 2. Tests indicated that the usual careful adjustments of the crystal detector were unnecessary, because the radio-frequency amplification preceding the detector usually gave sufficient signal

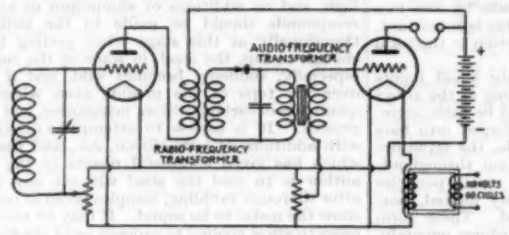


FIG. 2

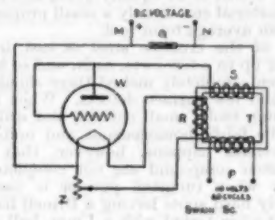


FIG. 3

current drawn from these cells is exceedingly small a battery used in this manner, and as shown in Fig. 4, will last for a very long time, and its employment can scarcely be regarded as a disadvantage.

Experiments showed that the practice of rectifying the filament current by means of a "Tungar" rectifier is unsatisfactory, for the resultant hum was much greater than that which was experienced when unrectified current was used, for during rectification the wave form is distorted and it becomes impossible to stabilise the grid voltage by means of the balancing resistances. Subsequently the battery used for supplying the plate voltage was replaced by a thermionic valve rectifier connected as shown in Fig. 3. The primary P of the small transformer T is connected to the power mains, and the winding R supplies the filament of the rectifying valve W at a pressure of 8 volts. The winding S gives 300 volt current, which is rectified by the thermionic valve W and smoothed out by the condenser Q, which has about 10 microfarads capacity. This arrangement gives at the terminals M N a high voltage direct current, which is quite suitable for use on the plates of amplifying valves. The resistance Z varies the brilliancy of the filament of the rectifier and simultaneously varies the plate voltage. The use of a loud-speaking telephone receiver, such as the "Magnavox," was made possible by applying an alternating current rectified by a Tungar rectifier to the field and coil of the telephone, the impedance of this coil being great enough to smooth out the pulsating current sufficiently to reduce the hum to a value which is not annoying. It was found advisable to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier by means of a 1 to 1 telephone transformer with a .02 microfarad condenser in series with the telephone circuit, as this also helped to reduce the residual hum in the telephones.

The final arrangement shown in Fig. 5 gives good amplification with a slight residual hum which is not objectionable when receiving signals of ordinary strength, whilst music and speech are said to be clearly reproduced. On switching over the amplifier from a direct current to an alternating-current supply, it was found that the amplification under the latter conditions was just as good as that obtained with direct current.

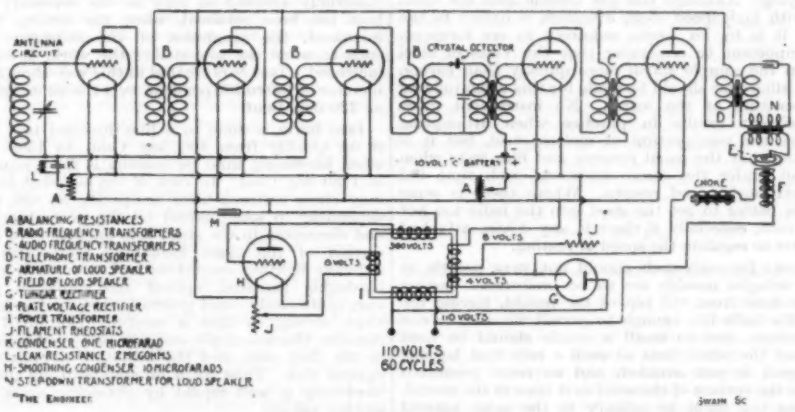


FIG. 5

strength to enable a sensitive point on the detector to be easily found.

This arrangement gave quite good results, for the 60-cycle hum was practically eliminated and the crystal detector gave almost as good rectification as the valve detector. It was found, however, that better amplifying action could be obtained by inserting .02 microfarad condensers shunted by 2 megohm grid link resistances in the grid circuits, in series with the sliders of the balancing resistances. The grid condensers and grid leak resistances allow the grids to assume a normal voltage which is more favourable for amplifying purposes, and the leak resistances allow any accumulated charge on the grids to leak off to the filaments. Still better amplification and quieter operation was produced by replacing the series grid condenser and leak in the audio stage with a 10-volt battery giving a negative charge to the grid. As the

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ACCURATE END MEASUREMENT.

SIR,—The writer has read with great interest the article on "Accurate End Measurement on Measuring Machines using a Screw," which appeared in your issue of July 28th.

The problem of accurate measurement for the workshop is a very important one. We need only take the case of a tolerance in the workshop of plus and minus .00025in. The gauges used to check this tolerance must be accurate to plus and minus .000025in., otherwise a considerable proportion of the manufacturing tolerance is lost. It is well to consider what happens in the tool-room where a gauge of this kind is usually measured with an ordinary micrometer. The gauge is made so that the inspector obtains a difference of .0005in. between one end and the other when reading with a micrometer. We will suppose that the micrometer has been set against slip gauges. The vernier reading will have an inaccuracy of not less than plus and minus .00005in., so that the measurement of difference on both ends of the gauge can be inaccurate by .0001in., or 20 per cent. of the workshop tolerance.

When the gauge wears out and a new one is made, again supposing that under the best of conditions the micrometer has been checked against slip gauges, the vernier reading difference of .0005in. will have an error of .00005in., and it may quite well happen this time that the reading errors fall on the inside of the limit, whereas in the first case they fell on the outside, so that the difference between the two gauges can be as large as .0002in.: in other words, nearly 50 per cent. of the tolerance.

It must be obvious, therefore, that accurate measurement is as fundamental a tool-room process as grinding, and that every tool-room should be equipped with a means of easily and cheaply obtaining a transference from their standards, *i.e.*, slip gauges, on to any kind of gauge which they wish to measure to an accuracy of plus and minus .00001in. Unfortunately, the machines hitherto designed for measurement seem to have been constructed with the idea of making the process of measurement as academic as possible.

The writer feels that every practical man will shudder when he reads the summing up of Mr. Baker's article, and notices that it is possible to obtain an accuracy of ± .00001in. without special refinements, only under the seven conditions he prescribes.

So long as measuring machines require treatment of this kind, the process of measuring can never be regarded as a tool-room process, but as useful only in the laboratory, where time and money are no object. The type of machine that is necessary for the tool-room must possess the following features:—First, it must be entirely free from the personal element of the operator, within the accuracy claimed for it. Its magnification must be large enough so that the variation in reading by different people becomes negligible. The magnification of the system must be such that there is no internal stress in it when set to zero, *i.e.*, that tapping or banging on the machine does not move the zero position. It must also repeat accurately, and its inertia must be a minimum, so that it can be operated quickly without overthrowing at the points of reversal. The machine should be capable of accurate operation when considerable vibration is present. Its anvil pressure should be a minimum to avoid distortion of cylindrical objects. The machine should use slip gauges as a means of comparison, since these can be produced to a far higher accuracy than any scale. They also have the advantage that in variation of temperature the standard has the same length as the gauge to be measured. The machine should not only deal with plain diameters, lengths, &c., but should also measure all the elements of screws, such as pitch, major, core and effective diameter on both internal and external threads. The machine should stand light blows—*i.e.*, not tappings—on the bed, without affecting the measurement, since such a vibration may occur at any time, owing very often to influences entirely outside the building in which it is used.

It is obvious that any machine using a scale and microscope will not be free from the personal element of the measurer. The magnification available is never large, owing to loss of illumination, shortness of focal length and loss of field due to any vibration that may occur. Also, the scale lines appear like troughs, and are difficult to locate accurately. One hundred magnifications is practically the limit of such a machine, so that the operator is faced with setting the lines to .001in. Anyone who has seen a rule engraved in 100ths will realise that it is impossible to divide accurately one of these spaces into ten.

Machines with mechanical amplification are limited by the inertia of the system. No matter how the magnification is carried out, the fulcrum or pivot of the last lever will have a certain stickiness, which in itself may be negligible, but when magnified by the multiplication of the system becomes so large that a considerable residual strain is left in the system, and when such a machine is set to zero a light tap or blow would instantly move the needle, owing to the release of this residual strain.

It is the writer's opinion that the large differences found by Mr. Henry Baker are generally due to residual strain in the amplifying mechanism. He evidently found that since he states that it was possible, by careful tapping, to obtain equilibrium about 2 a to the right or left of the normal position.

A. C. WICKMAN,
(ALFRED HERBERT, LTD.)

Coventry, September 6th.

BRONZE SLIDE VALVES.

SIR,—I have made one or two mixtures to obtain specially good results in the way of long life on a phosphor-bronze slide valve on a high-pressure cylinder working at 200 lb. pressure, and would be pleased to try any proved mixing that one of your readers has been using. If therefore any of them would kindly give his analysis, and any special comments, of what he has found to give the most satisfactory results I would be obliged.

WESTERN.

September 12th.

BOTH the Provisional Government and the Northern Parliament appointed Commissions to consider the question of the future of the Irish railways. That dealing with the railways of Southern Ireland was under the chairmanship of Lord Justice O'Connor, and it has presented its report, signed by the chairman and two of the three other members, wherein State purchase is recommended. It is not proposed that the management should be under a Ministry, but be administered by a council representative of the railways and other interests concerned. The dissenting member advocates that the railways be controlled by the State for the present or for three years, with a subsidy, where necessary, for a limited period. At the end of three years the railways to be amalgamated under a board representative of railway shareholders, railway labour, the Irish Treasury, the cattle trade, agriculture, and the commercial and industrial enterprise of the country, the board being under the chairmanship of an acknowledged railway expert.

Practical Notes on the Manufacture and Treatment of High-speed Steel.*

By H. K. OGILVIE (Coventry).

THE following notes deal chiefly with the manufacture of high-speed steel in the basic-lined electric furnace. Although the crucible is still largely employed as a melting medium the method is of little technical interest, being entirely a melting operation as no refining is possible, and a small amount of sulphur is generally absorbed by the metal. Although this element is not quite so dangerous as in ordinary carbon steel it is nevertheless advisable to keep it under about 0.06 per cent.

The labour and fuel costs are extremely high, but the plant and overhead charges are much lower than in the case of the electric process. The cost per ton of sound billets, however, certainly is in favour of the small electric furnace, even when the latter is only working nine or ten hours per day. The steel properly made by the two methods seems to be equally good, and this is important, as the material cost is only a small proportion of the total cost of an average form tool.

Most of the crucible steel is cast into small ingots weighing up to a few cwts. each, and so long as the alloys have been completely melted there should be little segregation and few surface defects. When forged into bars for turning tools, small cutters, and drills, the structure should be fairly homogeneous and uniform throughout. It sometimes happens, however, that small particles of tungsten compound are not completely melted, particularly when tungsten powder is used. These form extremely hard spots having a Brinell hardness generally over 600 when tested with a 1 mm. ball and a load of 30 kiloms., and they persist throughout the subsequent operations and may completely destroy a fine-toothed cutter working on the otherwise soft material. It is thus desirable to introduce the tungsten by means of ferro-tungsten or by use of a tungsten-chromium alloy.

The electric furnace is commonly used for melting this class of steel, and the charge may consist entirely of high-speed steel scrap together with a small amount of turnings. The latter should be heavy and clean and are placed under the electrodes and on top of the scrap until a bath is formed. Where a large amount of tungsten steel turnings have to be used up, it is preferable to add them gradually to the charge after it has been melted, but it is very much more economical to use only good scrap, that is, heavy clean scrap with a high tungsten content, and to reject the light and rusty turnings.

To attempt to make good high-speed steel from turnings alone, or where the greater part of the charge consists of turnings, is not, in this country, commercially possible. One cannot determine with accuracy the percentage of elements present, and this may necessitate the addition of large amounts of expensive alloys. If the turnings are clean and oily the carbon in the metal when melted will probably be too high: if they are rusty it will be too low with considerable loss of chromium in the slag. The latter will be saturated with oxides and must be removed from the furnace, as time cannot be spent in reducing these into the steel. Even when using heavy clean turnings which can very seldom be obtained in bulk, the loss will be at leat 10 per cent. With average turnings bought from a scrap agent the loss may be 20 per cent. or more. Added to this is the difficulty of melting the turnings without breaking the circuit or damaging the bottom, together with the increased repairs necessary to the banks of the furnace. On account of the high current and electrode costs every suggestion which tends to shorten the length of each heat should be encouraged, consistent with making good steel, but in any case, the time should not exceed 4½ hours for a 3 or 4-ton furnace.

When good scrap is charged the melting slag is comparatively clean and need not be removed, and the sample for analysis can be drawn as soon as the bath has been stirred up. During the next hour, while waiting for the content of carbon, tungsten, chromium, and vanadium, a heavy lime slag should be carried without getting the metal too hot. Probably a small amount of lump ferro-silicon may require to be thrown into the bath to deoxidise the steel completely, and the slag should be kept as white as possible, taking care that it is heavy enough to prevent the coal or ground electrode which is sprinkled on it from passing through into the metal. During this time most of the sulphur is removed from the steel.

The electrode coolers should fit closely enough to prevent the space between them and the electrodes acting as a chimney and drawing a stream of cold air through the furnace, having due regard at the same time to the slight variation in diameter of the electrodes themselves. With badly fitting electrode coolers, apart from the heat lost and the increased repairs necessary to the roof, the length of time required to reduce the oxides in the slag is prolonged whilst the consumption of electrode per heat is surprisingly increased. The doors should be heavy and a good fit. Double arches may be used with the best silica brick inside the furnace and ordinary fire-brick on the outside, the latter withstanding rapid change of temperature much better. A bricklayer accustomed to this class of work can keep down the cost of repairs enormously, and will seldom interfere with the normal working of the furnace. As in every other class of melting, attention must be paid to the furnace bottom and banks after each heat, particularly at the top of the banks where siliceous material from the roof and walls tends to gather. In the case of furnaces having a bottom electrode where the bottom is often considerably weakened by iron spikes or metal to increase its conductivity, it is very important to completely remove any metal from pockets left after tapping the furnace. These should be carefully filled up with magnesite or dolomite mixed with a little basic slag and allowed to partially fuse. Where a furnace of the Heroult type is in use, probably the best method of making the bottom is that employed for the basic open-hearth furnace, using oil burners if no other means of reaching the necessary temperature are available. Layers of good quality burnt dolomite mixed with a little basic slag are fritted on until half the thickness is reached. After saturating the bottom with slag and "setting back," the operation is continued, using layers of magnesite together with sufficient slag to render it just viscous at the maximum temperature obtainable until within a few inches of the necessary thickness. The top layers are completed with dolomite and slag and the furnace is finally held at a white heat for some hours by introducing coke between the electrodes.

By the time the metal has been melted, the percentage of carbon, tungsten, and chromium should only be slightly reduced, but most of the vanadium will have been removed. The necessary amount of crushed ferro-tungsten and ferro-chromium is added as soon as the analysis is obtained, and the temperature of the steel is gradually increased. When the bath is in good condition enough ferro-manganese is thrown in to give about 0.2 per cent. manganese, and five minutes later the ferro-vanadium may be added in a bag and well rabbled under the slag. The furnace should be tapped within the next ten minutes if the samples are quiet and the temperature sufficiently high, and no additions of aluminium or any deoxidising compounds should be made to the ladle or moulds. Occasionally at this stage when getting the metal hot enough to tap, the steel, in some of the smaller furnaces especially, suddenly becomes wild, and if cast will rise over the tops of the moulds even when considerable quantities of carbon, silicon, manganese, and vanadium are present. It is useless to attempt to deoxidise the steel with additions of ferro-silicon, &c., and the only method which has given successful results in the hands of the author is to cool the steel without any addition until after thorough rabbling, samples taken at regular intervals show the metal to be sound. It may be necessary in some cases to allow cooling to proceed until the steel commences to solidify round the banks. As this gas trouble has been quite widely known for a number of years, the author is rather surprised that so little mention of it has appeared in any of the home or foreign technical publications. Why high carbon steel containing up to 1 per cent. of silicon and melted with every possible precaution should, without any visible indication, suddenly become so wild as to flow out of the test ingot requires some explanation, when the slag is apparently in good condition and practically free from oxide of iron. It is difficult to believe that the trouble is due to oxide of iron, which can scarcely exist in such large quantities in the presence of elements having a greater affinity than iron has for oxygen. Also a sample ingot, badly honeycombed, after forging and rolling, showed apparently thorough welding of the gas holes, and gave impact and bend tests equal to sound steel of similar composition. At the same time there is undoubtedly a reaction between the gases and the silicon and manganese present when the steel is sufficiently cooled with consequent slight reduction of these elements, but during the time the metal is hot and wild there is no greater oxidation of silicon, manganese, or vanadium than normally takes place with sound steel under approximately the same conditions. Also the milder the steel to be made the more liable is the trouble to occur, taking into account the slightly higher casting temperature of the low carbon steel. This may or may not be due to the fact that no carburising material is added when the melting slag is removed. While the temperature seems to be extremely important the method and rate of generating heat appears to be more so. No such trouble is met with in a furnace such as the Rennerfelt, where heating is done almost entirely by radiation, or in basic Siemens practice, where equal temperatures are attained so far as can be judged by the fluidity of the steel. The metal in the electric furnace is always hotter when the first slag requires removal than it is when ready to tap the furnace, and when a clean slag is put on and fused, a small amount of ferro-silicon is sufficient to render the steel quite free from any tendency to rise in the mould. Yet as the refining proceeds and the slag becomes practically free from effective oxides, the danger of gas trouble appears to increase. In this way it is similar to overpoled electrolytic copper which, while theoretically free from oxygen, swells and evolves gases on solidifying. Although this gas trouble does not often happen with high-speed steel, attention is drawn to the fact that it is by no means unknown in arc furnaces.

It is important to remember that this class of steel oxidises in the sample spoon more quickly than carbon steel, and allowance should be made for this when judging the temperature of the metal. No instrument gives very consistent results in practice when attempting to measure the temperature of molten steel, but it is very seldom that the usual pouring and film tests when carried out under the same conditions each time fail to give extremely good results. Where there is some doubt it is better to get the steel into the ladle too hot than too cold, especially if there is any device attached to the latter to regulate the speed of casting.

The ingots for each melt should not vary greatly in size, and octagon moulds are to be preferred. Casting should be done from the top of the mould, having the metal in the ladle hot enough to permit the slag to rise to the surface, and as small a nozzle should be used as will pour the whole heat at such a rate that lapping of the ingots is just avoided, and no crust permitted to form on the surface of the steel as it rises in the mould. This allows the ingot to solidify in the most natural manner, preventing the formation of large tungstide network and keeping the pipe down to a minimum.

Bottom pouring may improve the surface of the ingot slightly, but as the whole ingot is in the liquid state when the mould is filled with the hottest metal at the bottom, partial segregation of tungstide results, to a serious extent when the tungsten is about 16 per cent. or more, and the ingot is over 5in. or 6in. diameter, unless the steel is dangerously cold. The waste of metal in the trumpet and runners, and the expense and time involved in using these, does not seem to be justified, and there is also the fact that this steel is much more searching on fire-clay material than any other class of steel, and it is not uncommon to have a runner burst when the casting operation is almost completed, leaving only a shell of metal in the moulds. It is perhaps unnecessary to add that the moulds should taper slightly towards the bottom, and the head box must be a good fit. Should metal be allowed to penetrate here it is quite likely that the shoulders of the ingot will not be able to withstand the tension set up during cooling, with the result that transverse surface cracks at this point will cause a considerable loss of material.

It is as well to keep the ingots under about 8in. in diameter and 10 cwt. in weight. When it is necessary to cast both large and small ingots from the same ladle, the Batty nozzle attachment is very convenient and is also useful when the temperature of the steel has been misjudged. In any case, when the ladle contains more than a ton or so of metal, one is justified in having two stopper rods, although the nozzles need not be of the same capacity. The sand used for testing the working of the rods must, however, be completely blown out of the ladle.

The ingots should not be allowed to become quite cold, but should be transferred to the re-heating furnace while they are still at a temperature of 200 deg. or 300 deg. Cent. So long as the ladle and moulds have been kept clean no serious surface defects should be visible, and a quick examination is all that is necessary before heating for forging. The billets, however, after cooling slowly must be very carefully examined, and any surface cracks and other flaws removed by grinding a little deeper than is thought necessary. The care expended in this operation ought to yield a high proportion of sound rolled bars free from seams and also free from straight surface cracks which are only visible after the tool has been hardened.

It is not good practice to make fairly large thin cutters direct from forged bars unless the bore of the cutter is extremely wide. It is preferable to use a medium-sized ingot and to forge it in the usual manner to 4in. or 5in. round. A blank cut from this is then thoroughly forged until the required diameter is obtained.

Many large cutters made entirely of high-speed steel are not by any means ideally forged, yet the outside of the cutter where the teeth are machined has often a fairly good structural appearance. Towards the centre, however, it becomes gradually coarser, and on hardening, fracture is liable to take place from the keyway in spite of the largest possible radius. Should there be no keyway, the cutter very often fractures when put to work. As this coarse structure is so easily detected under the microscope, and indeed very often with the naked eye on the polished and etched steel, the steel maker has no option but to replace any fractured material where it is present, even if the direct cause of failure be due to faulty hardening. At the same time there are few things so annoying as to have an intricate and eagerly awaited batch of cutters fail in the hardening operation, after considerable time spent on machining, and it is little satisfaction to know that the material will some day be replaced.

The general hardening practice is to quench the part in oil from a temperature of 1250 deg. Cent. to 1300 deg. Cent., and to temper it either in an oil bath at 220 deg. Cent. or in a salt bath at 600 deg. Cent. In certain cases, the tool may be hardened in an air-blast or may be allowed to cool normally in the air, depending chiefly on the size and design and whether the slight additional scaling may be disregarded.

The majority of high-speed steel tools seldom approach their breaking-down point when cutting in ordinary works practice, and for these a 14 per cent. tungsten steel with about 0.65 per cent. of carbon and 4.5 per cent. of chromium, with or without a small percentage of vanadium, gives quite satisfactory results, if hardened in oil from 1250 deg. to 1260 deg. Cent. and tempered at 220 deg. Cent. Where a heavy duty cutter has to work at its maximum efficiency better results are obtained from an 18 per cent. tungsten steel having 0.6 per cent. carbon and about 4 per cent. chromium with 1 per cent. of vanadium. This is hardened in air or oil from 1300 deg. to 1310 deg. Cent. and tempered at 590 deg. to 610 deg. Cent., when it has the greatest amount of secondary hardness or capacity to resist softening, until the tips of the teeth reach a temperature of 625 deg. Cent. or a little higher, the exact temperature depending on a number of factors. Laboratory tests show that by tempering at 600 deg. Cent. the apparent hardness is not materially affected so long as the necessary hardening heat has been attained, while the cutting hardness is increased, the toughness or the resistance to shock, such as when the tool strikes the work, is substantially increased. Test bars treated in this way show a toughness increase of 100 to 150 per cent. over the same steel tempered at 220 deg. Cent.

Less harm is done to a fine-threaded tool by rushing it up quickly from 800 deg. Cent. to 1300 deg. Cent. when hardening than by soaking it for a minute or two at 1250 deg. Cent. In view of the fact that some articles may show softness after tempering at 600 deg. Cent., depending to some extent on the percentage of carbon and chromium in the steel, it is important to make quite certain of the exact hardening temperature. Under different lighting conditions and with different types of hardening furnaces, optical and radiation pyrometers may quite easily—and generally do—read at least 20 deg. Cent. wrong, so that a carefully calibrated platinum-rhodium thermo-couple suitably protected should be used in the first case, and the radiation pyrometer checked against this. Time spent on standardising the details of hardening is well repaid by obtaining more consistent cutting values.

The length of time that the steel remains at the hardening temperature is most important. On production work, where a more or less constant amount of metal is passing through the hardening furnace, it is well to have the high temperature chamber about 10 deg. or 20 deg. Cent. above the correct hardening temperature, so long as the time in this chamber is a constant for the same class of tool.

It has been found by cutting tests extending over two years that Coventry screwing dies—and this therefore applies to many other fine-threaded tools—give better results when a high tungsten steel and a high hardening temperature are used, although the secondary hardness is not taken advantage of, as the teeth do not exceed at the most a temperature of 250 deg. Cent. under normal screwing conditions. Yet the resistance to abrasion is very high. One would presume that this is at least theoretically wrong, for with high tungsten a considerable number of brittle tungstide globules remain out of solution after hardening, and on the tips of the finest teeth would be

* Iron and Steel Institute, September, 1922.—Slightly abridged.

liable to break away from the matrix, as sometimes happens during the polishing of the steel for microscopic examination, and thus lead to wear and possibly fracture.

The hardening of certain screwing dies, which may have as many as sixty-eight vee threads per inch, is a most difficult operation when using the ordinary two-chamber furnace. Very little scaling is sufficient to clog up the teeth, and this scale cannot be removed by sand blasting, or the crests of the threads are blown away. At the present time, when many firms are well equipped with projection apparatus for measuring the form of screw threads by magnifying them fifty times or more, some better method of hardening is essential, failing the use of a steel capable of giving equal cutting results from a lower hardening temperature.

The difficulty has been overcome in the case of the contributor's firm by designing a gas-fired carborundum tube furnace for hardening these dies, with automatic feed, where the temperature of the maximum heat zone is accurately recorded and where the tool is in a slightly reducing atmosphere from the time it is introduced into the furnace until it enters the quenching bath. By this means there is no scaling whatever, and distortion troubles and also slight variations due to the personal element, which are so difficult to entirely eliminate, are kept down to a minimum or altogether avoided.

It is unfortunate that no rapid test exists for determining the actual cutting hardness of hardened high-speed steel. The file and the Brinell test are commonly used, but are by no means satisfactory. Both are useful when always using a steel of very nearly the same composition hardened under standard conditions, but neither gives definite information as to the cutting properties of the tool. Both serve, however, to separate material within fairly wide limits. Cases are numerous where one method of testing gives quite a different impression from some other method. For example, a low tungsten steel—carbon, 0.65 per cent.; tungsten, 6 per cent.; chromium, 6 per cent.—hardened in oil from 1000 deg. Cent. is quite easily filed, although on a section 1in. by ¼in. the Brinell hardness is 650. When hardened from 1300 deg. Cent. it is impossible to file it, although the Brinell number is not over 550. In both cases tools treated in this way cut high carbon annealed steel of 220 to 230 Brinell almost equally well. Similarly, an 18 per cent. tungsten steel oil-hardened to give 550 Brinell will not resist wear so well as the same steel hardened and then tempered about 630 deg. Cent. to give 550 Brinell.

Scratch and rebound tests seem to give anything but consistent results, and it would appear that magnetic and electrical tests have not yet been successful in solving this problem. A collection of all the known data from these tests would be valuable and might allow more work to be done in this direction.

Respirators for Railway and Industrial Purposes.

THE development of a pocket respirator which will largely alleviate the discomfort to which engine crews are subjected from the presence of sulphurous locomotive smoke when passing through tunnels is announced by the United States Bureau of Mines. The respirators are filled with an absorbent mixture of activated charcoal and soda-lime, and contain filters of Turkish towelling. They have had the hearty approval of the men who have used them, and are stated to retain their effectiveness for months. They can be cheaply made, and are claimed to be a great improvement over the sponge respirators, handkerchiefs or towels now used by drivers and firemen when passing through unventilated tunnels. The Bureau of Mines has also conducted tests to determine the efficacy of Army gas masks for use on locomotives in tunnels. It was found that these masks, having canisters filled with charcoal and soda-lime mixture and with a cotton pad filter, gave good protection against the smoke and irritant gases. One constituent of smoke, carbon monoxide, which is poisonous but tasteless and odourless, penetrates the canisters, but experience and analyses taken during the tests have shown that on moving trains the amount of carbon monoxide present was not enough to be dangerous.

The extreme discomfort caused by breathing sulphurous locomotive smoke while a train is passing through a tunnel is familiar to anyone who has been a passenger in a coach near the locomotive, especially if all the windows are not carefully closed. Bad as these conditions are for the passengers, they are almost intolerable in the engine cab, where the hot smoke and exhaust steam envelop the cab and fill it with hot, choking gases. The temperatures in locomotive cabs while passing through tunnels have been found to range up to 162 deg. Fah. Platelayers, too, are subjected to great discomfort in tunnels after trains have passed. Apart from the question of extreme discomfort, locomotive smoke may contain poisonous and asphyxiating constituents which have occasionally overcome, sometimes fatally, numbers of the crew of engines that have stopped in poorly ventilated tunnels. Several such cases are on record. In a tunnel, the tunnel crown deflects the smoke from the funnel upon and around the locomotive. Mixed with air and exhaust steam, the smoke enters the cab and surrounds the engineer and fireman with a hot vitiated atmosphere. The discomfort produced by the sulphurous smoke is intensified by the heat and humidity from the flue gases and exhaust steam. Slow, heavy goods engines going up a gradient through long, unventilated tunnels, cause most discomfort, especially when two or more locomotives are used.

Respirators of the "pig snout" type, containing wet sponges, afford some relief by cooling the gases and absorbing some of the irritating constituents of smoke. The protection afforded is not, however, complete, and most men will not take any trouble with such respirators, preferring to tie handkerchiefs over the nose and mouth. The experiments of the Bureau of Mines were conducted in twenty-three tunnels of the Baltimore and Ohio Railroad, between Grafton and Parkersburg, West Virginia, in the Gallitzin tunnels of the Pennsylvania Railroad, near Altoona, Pa., and in the Schenley Tunnel in Pittsburg. Various types of gas masks were worn by the experimenters in the cabs and by the engine crews in these tunnels; gas samples of smoke-contaminated atmospheres were taken in the locomotive cabs or at the cab windows and carefully analysed in the gas laboratory of the Pittsburg experiment station of the Bureau of Mines. Other tests were made by platelayers and by the experimenters while in a tunnel on foot.

These tests represent one phase of the work carried on by the gas mask laboratory of the Bureau of Mines. For many years the department has been making experiments to improve and perfect self-contained oxygen breathing apparatus for the conduct of rescue work at mine disasters, resulting from fires or explosions. More recently it has investigated the Army type of mask for the purpose of determining whether or not that type could be so modified as to be of service in work at smelters, blast-furnaces, or similar industrial plants. This investigation has shown that the Army type of mask, while affording protection against all the gases met with in warfare, does not afford protection against all gases encountered in industrial life. More especially, it does not protect against carbon monoxide, the gas present in coal mines, at gas producers, &c., nor against such common industrial gases as illuminating gas, natural gas, ammonia and the products of combustion found in burning buildings.

For this reason, the department has sought to impress on the public the limitations of the Army gas mask, and at the same time to develop special types of mask suitable for different industries or occupations, that will serve to protect the wearer from the gas risks encountered in a particular field of work. The department has also carried out work on a "universal" mask that would serve to protect the wearer against all the gases in air as commonly met with. A lightweight form of this universal mask has been developed for the use of city firemen. Pocket respirators were used satisfactorily, especially during the war, in many departments of the Government where workers were occasionally and for short periods of time exposed to low concentrations of poisonous gases. A common service was that of an emergency respirator to enable persons to escape from buildings when poisonous gas had been accidentally liberated. The charcoal and soda-lime filled respirator protects against certain acid gases and organic vapours. They should not, however, be used in petrol vapour. They afford no protection against ammonia, and none whatever against the carbon monoxide which may be found in products of combustion, and in producer gas, coal gas, water gas, and blast-furnace gas. The pocket respirators afford protection against the coarse smoke particles of locomotive smoke; but give very little protection against wood smoke, very fine dusts and fumes, such as those of tin tetrachloride, silicon tetrachloride or sulphur trioxide.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Coke Values Fail to Firm Pig Iron.

PIG iron is still only being bought in limited quantities. The consumptive demand at forges and foundries develops very slowly, but the stocks of raw material held by consumers have been so rigidly restricted that any new stimulus which the market receives will be immediately felt at the furnaces. Smelters have had little success in their attempts to raise selling prices to a level more in keeping with the cost of production. A trifle more than the recent price was paid in some special cases on the Birmingham Exchange this week. Values stand very much where they did a week ago. Users as a rule refuse to pay any more, and they are able to get their wants supplied by Staffordshire and Midland makers at 70s. to 75s. for forge qualities, and 80s. to 85s. for foundry f.o. truck at the furnaces. The principal effect in the Midlands of the advance of 2s. 6d. per ton announced in Cleveland No. 3 iron will be to assist Northampton makers in their competition in the Northern markets, Midland prices having for some months past been well under those of Cleveland. Nothing like the same progress is being made here as in the North of England, Midland smelters not regarding an advance in prices as at all within the range of possibility. The furnaces already operating in this district are considered more than sufficient to meet the demand. The furnaces are deriving a little advantage from some easing of coke prices, Yorkshire coke being obtainable slightly under £1 per ton.

Staffordshire Bar Iron Makers More Hopeful.

Hope has been kindled in the manufactured iron trade of South Staffordshire and the Midlands by the contracts which are beginning to circulate in some of the engineering branches. There is every reason to expect that other and more important contracts will follow, in which case there ought to be freer employment for the bar mills than they have had for a long time past. Makers of best iron are finding also a somewhat better demand for business connected with shipbuilding. In the shipbuilding yards there are some signs of returning animation. The stimulus cannot fail to communicate itself to the iron and steel industries. Thus far it has only been slightly felt in the Staffordshire trade, but there are evidences here of the quickening interest in prospective supplies and prices which is the forerunner of increased activity. Unfortunately, export business continues to be hampered by the chaotic conditions on the Continent. Prices are irregular, partly because of the increasing variety of the grades of bars produced, and partly through the unstable condition of the market. Marked bars continue to command £13 10s. per ton, a price at which they have stood for many months now. Merchant bars are quoted from £10 10s. to £11 5s., according to quality. The basis price for nut and bolt bars is upheld at £9 17s. 6d. With the resumption of work at Darlaston and Wednesbury after the Wakes, a few orders for nut and bolt bars have been given out. They represent only a small tonnage, however. There is a fairly steady demand for fencing iron, which continues to command from £10 to £10 2s. 6d. Gas strip shows signs of weakening, and it is reported this week that sales have been effected at £10 15s., which is from 5s. to 10s. less than the price which has been ruling for some months past.

Galvanised Sheets.

Makers of galvanised sheets continue fairly busy, and have managed up to the present to maintain the higher prices lately established. Quotations continue to range from £16 7s. 6d. per ton for corrugated sheets of 24 w.g. up to £16 15s. at works. Buyers are chary at the higher figure, and, in view of the amount of idle plant, when a good order is at stake, it is not being insisted upon. Thinner gauges continue firm and in fairly good demand. There is a little more demand for steel sheets, and some talk of increased prices.

Steel Requirements Expanding

The lowering of steel prices seems at last to have had the desired effect, and this week some buyers have been tempted to come forward with a few orders. They are operating only tentatively, however. Consumers are not purchasing ahead of actual requirements. It is only because these latter are expanding slightly that raw material is receiving more attention. There are still those consumers who hold the opinion that prices will fall even lower, and they are continuing to hold business up. Steel sections have not properly settled down since prices were decontrolled, and the tendency is stated to be in the direction of weakness. The big steel works are cutting quotations with a view to securing their profits by means of output. This has already given a quietus to Belgian competition, sales of foreign billets having ceased for the time being. Recent quotations for angles have been as low as £8 15s., though many sellers adhere to the £9 quotation. Midland steel masters are amongst those who do not take kindly to the reductions, and they continue to quote on the higher basis. It is now possible to buy British billets under £7 per ton delivered Birmingham, a figure with which Belgium cannot compete even at the present low value of the franc. In fact, several quotations lately received have been several shillings per ton above those quoted by South Wales. Supplies of sheet bars have this week been offered down to £6 17s. 6d. Business has been reported at even less, but these transactions appear to be exceptional cases. Finished bars (⅜in. to ¾in.) can still be bought at £9, that being the figure at which sellers are prepared to close in the case of a good order, though the starting quotation is about 10s. more. Complaints are heard on all hands on the unprofitable nature of present-day business. The local steelworks are now, however, less subject to competition from the Middlesbrough area, owing to the serious obstacle of railway rates. This enables steel masters in this district successfully to continue their policy of quoting uniform prices. Nevertheless, the general experience seems to be that the selling price by no means covers the cost of production.

Reduction in Steel Wire Prices.

Midland and Lancashire makers of steel wire have just declared a reduction of £1 per ton in all qualities. The basis for bright mild steel wire in hundredweight or half-hundredweight coils now becomes £19. For catch-weight coils it is £15 7s. 6d. Galvanised and copper wire are reduced to £22, tinned to £33, and half rounds up to 8 gauge to £28.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THERE is a slightly better feeling in the local markets for iron and steel, if not for the non-ferrous metals, and one can only account for it by the theory that the American purchases in the North are beginning to have a reflex action on the markets in the Midlands. America has not begun to buy any British steel and the Midland pig iron is not supposed to suit her requirements; that is to say, the analysis does not come up to her ideas. Large quantities of Midland coal are being shipped from the East Coast, and as Midland pig iron is now 10s. per ton cheaper than Cleveland, it would certainly go were it not for this prejudice. The danger in connection with this American demand is that it may suddenly cease or leave the market in an exhausted condition. It is said that American furnaces are getting into order now that the coal strike is over, and will soon be in a position to supply all home needs. Hence to start up more furnaces here on the strength of this demand appears to be rather risky.

Metals.

The movements in the copper market have been rather insignificant of late; but it is noticeable that the gap between electrolytic and best selected ingot copper is widening and one finds some difficulty in accounting for it. Considered intrinsically, best selected ingot is worth about the same as electrolytic. Of course, it cannot always be used for the same purposes, but its pure copper content is very nearly the same. Nevertheless, there is at the moment a difference of £4 to £4 10s. per ton in the prices. There is more difference, in fact, between these two refined coppers of practically the same purity as there is between standard and best select, where a difference in purity of 3½ per cent. may exist. The rising price of electrolytic, the stationary price of best select, and the considerable advance in good clean scrap copper are features which seem to call for study. For instance, best select has remained stationary at £66 to £68 per ton, while clean scrap copper has risen by £5 per ton. Not so long ago dealers were offering £52 for clean scrap; now they are paying £57, and one meets occasionally with offers up to £58. It is reported that the general consumption of copper in this country is increasing, and some people

believe that orders which were going to Germany have been diverted to Great Britain because of exchange difficulties. It may be so, but in this district one does not find much activity amongst users of copper. It is, however, true that Germany has not been buying very much copper of late; but this may be accounted for by the fact that she has already secured as much as she wants for the present. Certainly German purchases in the early part of the year were very large. The local demand in America is reported to be better, and in this case it is improbable that American copper prices will be reduced. As to the matter of a rise, this is rather more doubtful. At any rate speculators on this side do not seem to be anticipating it yet. In the market for tin, things are steady and very quiet. The price has kept near to £160 per ton for more than a month, and this is a long time for quiescence in the tin market to last. It is believed that American buying will soon set in again, and this may give a fillip to the market. No doubt the knowledge of the existence of a large reserve stock in the East has a steadying influence, so soon as prices begin to advance, on any improvement in the demand. Lead and spelter have shown very little change. Consumers of lead are still inclined to buy only for prompt consumption, and, of course, this keeps the spot price above that for forward delivery. There seems now to be some apprehension that Mexican supplies will be lessened by the disturbance in that country. Very little spelter is now coming in from abroad, but the home production keeps good, and there seems to be as much metal as is wanted.

Pig Iron.

Although there has been some improvement in certain sections of the pig iron market lately through the persistent American buying, the effect of this is felt only very slightly in the Manchester district, and it is still possible to buy Midland pig iron at the old prices, say, about 90s. per ton delivered here. Of course, there has been a serious rise in Scotch iron because the American demand was first concentrated on that class of pig; and the consequence is that there is now quite a scarcity, and makers are asking prohibitive prices up to £6 5s. per ton for delivery in Manchester. The trade here in Scotch iron has declined, and it is very difficult for merchants to get orders. There has always been a theory that Scotch pig iron was essential for a good deal of the foundry work which is done in the Lancashire district, but under the stress of this big price the theory is undergoing a severe test; and if the difference of 35s. per ton between Scotch and common No. 3 pig is maintained for any length of time the sales of Scotch in this market may be permanently injured. The actual demand for foundry iron here is small, and many of the ironfounders are short of work. Cleveland iron is becoming almost as scarce as Scotch, but only one or two founders here take any interest in it, as, when the increased carriage is paid, it is far too dear for ordinary work. The price of No. 3 Cleveland delivered in Manchester is now about 105s. per ton; and plenty of Derbyshire iron of equal quality can be bought at 90s.

Steel.

The market here for finished steel is much as it has been since the restriction on the prices was removed. From other districts there are reports of an improved demand, but in Manchester this is not apparent, and one has the impression that the greater demand is the result of taking utterly unremunerative prices, such as £8 10s. and £8 15s., for steel plates. Here the makers of plates are trying to keep the price up to £10, and complain that even then they are selling at a serious loss.

Scrap.

Dealers in scrap iron and steel complain that the demand is no better. For heavy wrought scrap, delivered at the Lancashire ironworks, only about 65s. per ton can be obtained. Good cast machinery scrap, really worth, intrinsically, more than common No. 3 pig iron, is on offer here at 10s. less per ton; and textile scrap, which used to sell at near the price of Scotch iron, is being offered at 40s. per ton less.

Air Race Impressions.

The great air race for the King's Cup created considerable interest in Manchester, which possesses one of the finest and best-equipped aerodromes in the kingdom. This aerodrome is situated within three miles of the centre of the city, and has the advantage of being easy of access by road or rail. There was a very large concourse of spectators to witness the arrival and departure of the competitors on their way South. The details of the competition have been very fully dealt with in the daily Press. Manchester people were chiefly interested in the performance of the Avro machines, built by A. V. Roe and Co., a firm which did much pioneer work in aeronautics prior to the war. The Avro machines were, however, unfortunate, and lost all chance of victory on the first day. Of all the machines which reached Manchester it was noticed that only one was propelled by a rotary engine, and singularly this was the only engine which met with mechanical trouble. It would seem that the vertical water-cooled engine has now superseded the rotary air-cooled motor for this kind of work. All the engines of this type came through the ordeal successfully, and beyond replenishing with oil and petrol, required no attention at Manchester. Several of the pilots complained of the intense cold which they experienced in their flight from Glasgow, and it would seem desirable that for work of such severity more adequate protection should be provided for the pilot and passengers. The excellent performances of so many of the competing machines demonstrates that British engineers are well in the van of progress in spite of the outcry on the part of a section of the Press. The design of the two Boulton and Paul machines was much admired, and their builders are to be congratulated on the way in which these aeroplanes acquitted themselves.

BARROW-IN-FURNESS, Thursday.

Hematite.

The American orders have had the expected result. Stocks held by some makers who accumulated them during the engineers' dispute have been cleared or are sold and awaiting dispatch, and in the case of others very little remains. In the case of one works there is not an ounce of stock, and orders are being urgently sought. There is some talk of one firm endeavouring to secure a contract which will mean a delivery of a thousand tons per week. Trade generally is better, and another furnace has been put in blast in Millom, and the North Lonsdale Iron Company is to put its furnace at Cleator Moor again into work. Inquiries are bulky in number, but in the majority of cases the amounts are not heavy. Sheffield continues to be a steady customer, but most of the parcels delivered are well under 1000 tons. The Continent continues to promise better trade, and there are also signs of awakening both in the Midlands and Scotland. There are great hopes of the latter eventually. Shipments of pig iron continue, and there has also been a dispatch of ingot moulds for South Wales. There is a steady demand by America and the Continent for manganese iron, and an improving prospect for special sorts and spiegel. The hematite iron trade is undoubtedly on the turn now.

Iron Ore.

With the putting into blast of more furnaces the local iron ore industry will benefit, and it is expected that there will be more activity in this trade in the early future. There are shipments coastwise of small cargoes, and these will develop as the general trade of the country improves. The foreign ore trade is also likely to improve, but imports during the past month or two have not been heavy by any means.

Steel.

The steel trade continues to be satisfactory, speaking comparatively, and both rail and merchants' mills have orders which will keep them going for a few weeks, and further orders are being sought. The foundries continue to be moderately employed, and the hoop mill is busy. The latter department has, we understand, orders in hand which will keep them going for the next thirteen weeks or so. Last week there was an incoming cargo of steel billets from Antwerp by a steamer which took back pig iron to the same port.

SHEFFIELD.

(From our own Correspondent.)

Autumn Prospects.

THE position has not materially changed during the past week, and the second week of September brings the hoped-for autumn revival very little nearer realisation. Orders are reported by some manufacturers to be a trifle more numerous and from a wider area, but in volume they still represent a very meagre contribution towards the solution of the local unemployment problem, concerning which the city's authorities are getting extremely anxious as winter approaches. There is no further development in connection with the suggested deputation to the Prime Minister representative of the industrial areas which have been badly hit by the suspension of naval and armament orders. This effort was to have been made ostensibly in the interests of the unemployed, but a curious sequel to the announcement has come in the shape of an intimation from one of the leaders of the Sheffield unemployed—who still number about 40,000—offering a protest against the action of the Lord Mayor in seeking this solution, and suggesting that they can offer alternative proposals for schemes of more permanent utility than preparations for war.

Iron and Steel for Export.

Meantime it is significant to note that a large proportion of what increased activity there is in the production of iron and steel is due to export demands rather than to home manufactures. The engineering trade is not yet making much call for Sheffield steel, and the home railways and shipyards are equally sparing in their orders. One or two representatives of important local firms who have recently returned from continental tours are, however, quite satisfied with the results of their negotiations with prospective customers. Great hopes are also entertained of overseas orders yielding a useful volume of work in the early future. Germany's era of cheap production seems to have come to its inevitable end, and in the view of local manufacturers no serious competition need now be feared from that quarter.

Tools and Cutlery.

Local tool manufacturers are still having a very thin time, and cutlery and hardware firms are not much more fortunately circumstanced. Some of the biggest retailers of South Africa have, however, been over here lately, and Sheffield has, I believe, obtained a fairly satisfactory share of the business that has been placed. The home trade is still very dull, and likely to remain so until, in the case of tools the engineering trades show greater activity, and in cutlery the Christmas trade commences. In view of the widespread depression, however, this latter prospect is likely to prove a disappointing one for Sheffield manufacturers who cater for such trade. Spring knife makers are still at a standstill in consequence of the dispute with the unions respecting the new price lists, in connection with which a deadlock has been reached, both sides having stood firm for several weeks past.

Scrap and Raw Materials.

Purchases of raw materials and scrap on a rather more generous scale than has been noted for many months past would seem to indicate that local steel makers are not without hope for the future. To a certain extent this activity is in the nature of a precautionary measure, for there are signs that prices may rise again, especially with America participating so energetically in the market. A somewhat anomalous position has been created by the fact that Germany is now sending to this country scrap from the British warships which were sent to Germany for breaking up.

Gas and Electricity.

Some interesting developments in connection with the Sheffield gas and electricity undertakings are taking place. The gas company is further reducing its charges as from the September meter readings, bringing the cost down to the equivalent of 3s. 4d. per 1000 cubic feet, which price, it is claimed, is one of the lowest in the country—an honour which the company had the distinction of earning before the war. Leeds, for instance, even with the latest reduction, is still at 4s. 6d. The Sheffield company has also been engaged in carrying out various improvements in the manufacture and supply of gas. The new vertical retorts at one of the works are now approaching completion, and this large plant would have been in operation this month, except for delays owing to the dispute in the engineering trade. Five miles of high-pressure mains have been laid, and compressors installed at another of the company's works. Further coke oven gas is being obtained from the Tinsley Park and Orgreave collieries, and new chemical works at Grimesthorpe have been completed and brought into use and a chemical engineer appointed to take charge of this plant. The Electricity Department of the Corporation has now come to terms with the local electrical fittings contractors with regard to the retail sale of fittings, concerning which there has been a feud between the parties for years past, involving the abandonment of a proposed new sales department. Now, however, the Corporation is to provide, equip and maintain a show-room for the display and demonstration of electrical apparatus of any description, and can sell direct to the consumer all such electrical apparatus, other than electrical fittings, beyond the ceiling rose, wall plug, or floor outlet for electric lighting installations, but the Contractors' Association agrees to co-operate with the Corporation in the sale of electric fittings for lighting installations which the Corporation may only sell through a contractor. The agreement is for ten years.

Foundry Trade Technical Society.

Workers in the foundry trade have so far held aloof from the technical society movement which has made remarkably rapid and effective progress in connection with the tool, cutlery and metallurgical industries of Sheffield, but thanks to the persistent and persuasive overtures made on behalf of the University authorities, under whose auspices this movement has been fostered, this antagonism has now given place to enthusiastic support. This found expression at a meeting of representatives of the trade held at the Department of Applied Science of the University last week-end. Dr. Ripper, Head of the Department, who presided, explained that the trade technical society movement had been of considerable help in other industries. It provided a means by which persons engaged in the industry could come together, and on neutral ground, frankly discuss their difficulties, and find ways and means to overcome them. It also provided opportunities to enable the workers to share in the promotion of developments and improvements in their trade. The workmen had already shown unexpected interest in this movement, and had taken a lively part in discussing the lectures and papers which had been put before them. It was now proposed to do for the foundry trade of the district, including the iron, steel and brass trades, what had already been done with success for cutlery, the silver trade, the file trade, the edge tool trade, the rolling mill and forge workers. Representatives of the various sections of the foundry trade who were present expressed their readiness to further in every possible way the objects of the new trade society, and a resolution was unanimously passed approving the proposal. This was warmly supported by Dr. Percy Longmuir, a past-president and the original founder of the Institution of British Foundrymen, who said from his own experience he could testify to the excellent results that had already been effected by helping the workers to a knowledge of the why and the how of the various results which were achieved in every-day practice. Officers of the new society are now being nominated.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE trade position in the North of England continues to improve and a more hopeful view is taken of the outlook. At the same time progress to a normal state of industry proceeds very slowly, and it is realised that some considerable time must yet elapse before the tide of depression is completely turned. Several of the steel works and ironworks on the North-East Coast still stand completely idle, while others are only working to partial capacity.

Cleveland Iron Trade.

Business in the Cleveland iron trade has shown such a marked improvement recently that there is now something akin to a famine. American consumers have bought up practically all the available supplies, and there is little on offer for this month's delivery. A confident feeling prevails regarding the outlook, and this is indicated by the fact that two more furnaces have been put into operation this week. The demand from America is still good, and the prevailing opinion is that it is likely to continue for some time to come. Although the coal strike has ended in the United States, there are still very few blast-furnaces working, and as the railways are disorganised, pig iron supplies are very scarce and dear—so scarce and dear, in fact, that it is still much more profitable for works near the Atlantic seaboard to import iron from Britain. Supplementing this strong American demand has come a rather better inquiry from the Continent and a bigger consumption of iron by the English and Scottish foundries. Coastwise shipments to Scotland are heavier, and as Scottish No. 3 foundry is now selling at 100s. per ton,

Cleveland iron is in fair request amongst Scottish consumers. Prices are very firm, No. 1 and siliceous iron being 97s. 6d.; No. 3 G.M.B., 90s.; No. 4 foundry, 87s. 6d.; and No. 4 forge, 85s.

Hematite Pig Iron.

The hematite pig iron trade is not in such a satisfactory position. Some of the makers are carrying very large stocks, and even at a loss are anxious to liquidate. While some firms still hold out for 90s. per ton and more, mixed numbers can be bought at 89s., and even 88s. might not be refused for a substantial order. These prices are admittedly below cost, and certainly as soon as stocks are reduced they will not be repeated.

Iron-making Materials.

There is little or no business passing in the foreign ore trade. Consumers are well supplied, and in view of the present high price are not disposed to enter the market. The recent lighting up of more furnaces had encouraged the hope of better business, but this has not yet materialised. Best Rubio ore is still nominally quoted at 24s. 6d. per ton. The strong foreign demand for coke keeps up the price in the home market, and although consumers talk of 26s. as the price of blast-furnace qualities, good Durham brands are still realising 26s. 6d. to 27s. per ton delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade shows no further improvement. There is a little more interest in the position, and a few rail orders and constructional specifications have been placed; but the volume of business is still small, and price cutting for orders is very keen. Business is reported in steel ship plates for export down to £8 7s. 6d., and £8 for sections; but in the home trade the prices are higher. Common iron bars can now be secured at £11, iron angles at £11, and iron ship rivets at £12 17s. 6d.

The Coal Trade.

The Northern coal trade does not display anything in the way of special features. There is not quite the same pessimistic feeling with regard to the forward outlook. Most of the operators, both collieries and exporters, are hopeful that the present conditions and values may possibly be maintained throughout most, if not all, of the coming winter, and in some instances may possibly improve; but much will, of course, depend on the strength and volume of the trade from the Continent, which at the present moment is very moderately coming forward. The trade with America is rapidly falling away, and is not expected to mean more in the future than possibly odd cargoes now and then, though Canada ought to continue to purchase for some time yet. The French market is giving signs of expansion. One or two large contracts have been placed, and others are either under consideration or may be looked for. Italian business keeps very low and much below the normal. The adverse rates of exchange operate disastrously there, and also against the German trade; otherwise much more business might be transacted. The inquiry from Norway, Sweden and Denmark is also very slow and spasmodic, owing to the current high prices. The general tone of the market continues to be easy, and though this is not reflected in the prices to any appreciable extent as yet, there is every reason to suppose that unless there is an influx of new business soon values will begin to shrink. The Northumberland steam coal trade is still fairly busy, with 25s. per ton direct being indicated for any available supplies of best qualities. Second screened steams are also fairly steady, while all classes of steam smalls are well upheld at full figures. The Durham market, however, is anything but uniform and displays a number of weak spots. Some of the collieries are comfortably situated, but the bulk of them are seeking for trade, and in some instances are prepared to discount for a prompt teem. The coke position is fully upheld. Gas coke is firm for any date of loading, while foundry coke of all kinds is in good request at full quoted prices.

SCOTLAND.

(From our own Correspondent.)

Less Hopeful Outlook.

FOR some two or three months there has been a feeling in trade circles that the autumn would see a speeding up in most branches of industry. Very little has happened to bear out such expectation, and opinions are now inclined in the opposite direction. The hope of brisker times succeeding the "Fair" holiday is unrealised, and it would appear evident that no material improvement can be looked for this year. Occasional spurts have been, and may yet be, experienced, but any lasting improvement under present conditions seems out of the question. Wages and other costs have depreciated, but even at present levels are said to be too high to allow of workable profits. In any case, apart from a very few shipbuilding orders and one or two general contracts, new business generally is of a very meagre description. Consumers cannot or will not pay the prices asked, and therefore, even when the business is there, it is either held back or goes abroad. The shipbuilding orders already referred to will brighten prospects in the immediate vicinity of the fortunate yards, but the industry generally is in an extremely dull condition. At one famous yard on the upper reaches of the Clyde there are now employed only some 250 workers instead of the usual thousands. The situation in the industry was referred to at the final trial run of the Anchor liner Tuscania, built by the Fairfield Company, to replace the earlier Tuscania built in 1915, which was torpedoed by a German submarine. The new Anchor liner is the largest and most up-to-date passenger vessel sailing from the Clyde.

Pig Iron Firmer.

Though the home demand for Scotch pig iron is poor, America and Canada continue to buy fair quantities of foundry qualities. Stocks of these are low, and prices are therefore still inclined to go higher. The demand from overseas is expected to continue for some time, and it is probable that more furnaces will be put in blast. Intimation is to hand of at least one concern which is to restart operations after being idle for a considerable period. Hematite is slow to move, but is unaltered in price.

Finished Steel and Iron.

Steelmakers are still very short of orders for plates, any contracts given out so far in connection with new shipbuilding work having made very little difference as yet. Sectional material, too, has fewer demands. Consequently, though quotations show little alteration, the tendency is easier. It is said that ship plates have sold at £8 7s. 6d. for export, and sections at £8 per ton. Home prices for similar material have been mentioned at £9 and £8 15s. per ton respectively. Steel sheet makers are chiefly engaged on light gauges for export, but are also rolling some quantities of heavy gauges for both home and export delivery. The demand for sheets from India and Australasia is maintained. Galvanised sheets are inclined towards firmness. The bar iron works are making little headway. Orders are few and far between, and it is now difficult to arrange for more than three or four days' work per week. Prices remain unchanged meantime. Rerolled steel bars are a shade busier, but a trifle weaker in price, £9 having been done for export. Scrap material has lost none of its firmness, and steel works material in particular is difficult to obtain. Tube makers are rather better off for new business at present.

Coal.

The position of the coal trade has altered somewhat during the past week. American demands for round coal have stopped and forward business is scarce, even from continental sources. Collieries have still a fair amount of work on hand, but the outlook is uncertain. As a result, holders are inclined to moderate quotations to attract business. The Lothian and Fifeshire districts continue busy with orders for washed material, but even this trade has eased a trifle. Buyers are becoming more and more disinclined to anticipate requirements at present prices, and especially for home deliveries. A fairly regular turnover in best household fuel is going through, but nothing of any consequence is passing in other directions. Aggregate shipments amounted to 384,102 tons, against 364,219 tons in the preceding week and 333,710 tons in the same week in 1913.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE has been no development in the coal export trade during the past week such as to cause any feelings of satisfaction regarding the future welfare of the industry. On the contrary, the position is rather the reverse. The market is gradually but surely slipping downward on account of the fact that the demand is not being maintained. America is doing little in the way of further purchases, and her requirements are practically confined to dry coals and anthracite. Business respecting a few occasional cargoes may be carried through, but it would be inadvisable to reckon on the inquiry from this direction being on such a scale as to have any material influence on the conditions of this market. In the case of Canada it is questionable whether the volume of business for the Dominion has reached anything like the amount that was expected, particularly in view of the reports which have been received regarding the seriousness of her fuel position. Business is still being carried through for Canada, but there is no sign of any great expansion in her requirements, which must be arranged for fairly early shipment if she is to get supplies before the closing of the St. Lawrence. Cargoes arranged for the States and Canada are now being loaded, and it is interesting to note that for the week ending the 8th inst. our exports to America totalled 213,000 tons out of a total of 597,000 tons from this district. This is equal to 36 per cent., so that it will be appreciated to what extent South Wales is dependent upon a new market for the outlet of her coals. Considering that this outlet may close within the near future, it is altogether impossible to feel easy regarding the prospects of the industry. Without laying oneself open to the charge of being pessimistic, there is no doubt that it is preferable to face the outlook and the facts, rather than attempt to disguise the situation. It may be doubted whether prices of steam coals will revert to the level experienced before the Americans came into the market, but unless there is a radical improvement in the demand from the regular markets of South Wales it is difficult to see how even present values can be maintained. Continental consumers are able to gauge the position as well as people on this side, and there is no doubt that in their opinion the market can only fall immediately the American and Canadian demand ceases off. This being the case, they display no readiness to purchase coals, but naturally they prefer to look on until they think that prices have fallen to the lowest level. The consequence is that there is very little buying at the moment, and any exporter who quotes for business must discount present prices to an appreciable extent if he is to stand any chance of closing an order.

Swansea Harbour Trust.

It is interesting to note from the report presented at this week's meeting of the Swansea Harbour Trust that the volume of trade for the month of July, viz., 587,441 tons, was the largest quantity in post-war times. Imports showed an increase in all items except grain and gas coal. The increase in exports amounted to 300,000 tons, made up of 208,500 tons of coal, 20,000 tons of patent fuel, 26,000 tons of tin-plates, and 43,000 tons of oil. The quantity of oil imported and exported was no less than 124,000 tons. The financial result of the month's trading showed a profit, after providing for maintenance and the full amount of interest, of £1980 19s. 11d.

Newport's New Orders.

The announcement is made that during last week-end a substantial number of important orders was secured by Lysaght, Limited, with the result that there will be a considerable amount of work for the firm for some time ahead. Its mills employ about 3000 men and are going night and day. Orders have been received from Burmah by the British Mannesmann Tube Works for oil pipe lines. About 800 men are now employed, and there is a prospect that an additional number will be engaged.

Coal Trade Matters.

At a meeting of the Conciliation Board for the coal trade held on Tuesday the men's leaders renewed their application to the coalowners that the latter should co-operate with them on the non-unionist question, but the owners again intimated that they were still not prepared to take any joint action with a view to inducing workmen to join the Federation. Their view is that it is not part of their function to recruit members of the men's Federation. The question of the lower-paid workmen in the coalfield was also raised. The men's leaders requested that in order to improve the present unsatisfactory position of the lower-paid men the following additional allowances should be made:—6d. per day to boys up to eighteen years of age; 9d. per day for those between eighteen and twenty-one years; and 1s. per day for adults, with a maximum of 7s. 8d. per shift. After some discussion consideration was deferred for a week, and in the event of failure to agree it was arranged that Lord Buxton, the independent chairman, should be called in to decide.

Current Business.

On the whole the steam coal market during the past week has been quiet, and in these circumstances prices are weaker. The demand from abroad is very restricted, consumers showing no eagerness to come into the market. The position of collieries varies very largely, and this fact is reflected in the prices that they are indicating for supplies. Some collieries have good steams for the moment, but few, if any, of them are so well off for business that they could not do with further orders. Dry coals are as firm as anything in the market on account of the shipments of these coals to America, but there is no grade now being quoted above 29s. Smalls are also easier, and the best qualities are obtainable at 18s. 6d. The inquiry for patent fuel is also quiet, but coke is fairly steady. The anthracite market keeps quite firm, and collieries are very well booked up.

Latest News from the Provinces.

NORTH OF ENGLAND.

Further Advance in Price of Pig Iron.

THE inquiries for iron on the Cleveland market continue to be most encouraging, and there is a marked scarcity of the better qualities. The market is exceedingly firm, and makers now refuse to consider business for No. 3 G.M.B. Cleveland pig iron below 92s. 6d., which represents an advance of 2s. 6d. per ton on the week.

WALES AND ADJOINING COUNTIES.

Collieries' Serious Position.

In connection with the demand of the miners for a subsistence wage for the lower-paid workmen, the chairman of the owners' side of the Conciliation Board has stated that there are a number of collieries which have come to the end of their resources, and which do not know whether they will be able to continue operations, even with the present wages. The effect of paying a subsistence wage will be to cause the closing down of many collieries, with consequent unemployment.

Swansea Metal Exchange.

The tin-plate trade shows no change. Business is very restricted, but prices remain steady. The galvanised sheet industry displays a better tone, and works are pretty well off in the matter of orders.

IT is reported that Mr. Lasker, chairman of the United States Shipping Board, declares that a movement is afoot to form an American steamship company with a capital of 30,000,000 dols., which will build two electrically driven liners each of 70,000 gross tons and 1000ft. in length. The scheme has already advanced to the stage at which the plans are under preparation. Mr. Lasker adds that Congress had authorised the Shipping Board to set aside 25,000,000 dols. annually for a ship construction loan fund, and that if the projected ships were of an approved type the plan would receive the support of the Shipping Board.

THE deepest mine in the world is situated about 150 miles west of Rio de Janeiro, where the St. John del Ray Mining Company has burrowed in the earth, following a rich vein of gold ore, until the workings are nearly a mile and a-quarter beneath the earth's surface. The temperature rises 1 deg. for every 120ft. in depth, and on the lowest level (6426ft.) the temperature of the surrounding rocks is 118 deg. Fah. No one could work at such a temperature, and it is only through providing abundant fresh air forced in by fans that the men can work effectively in the St. John del Ray mine. The company has tried the experiment of refrigerating its fresh air before forcing it into the mine, and an American investigation is now being made to ascertain whether pre-cooling the air is enough of a success to justify its adoption in those mines in the United States where high temperatures are encountered in the deep workings.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 9 9	4 9 0
No. 1	4 9 6	4 9 6
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 6 6	—
Foundry	4 6 6	—
Forge	4 6 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	11 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 10 0 to 11 5 0	
Marked Bars (Staffs)	13 10 0	—
Nut and Bolt Bars	9 15 0 to 9 17 6	
Gas Tube Strip	11 0 0 to 11 5 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 10 0	—
Ship Plates ¾in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ¼in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 0 0	—
Angles	8 10 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 10 0	—
Channels	13 10 0	—
Hard Billets	8 0 0	—
Soft Billets	7 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 0 0	—
Boiler ,,	13 10 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Soft ,,	7 5 0	—
Hoops	12 5 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	9 5 0 to 9 10	
Billets and Sheet-bars	7 0 0 to 7 2 6	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 7 6 to 16 15 0	
Angles	8 15 0 to 9 0 0	
Joists	9 0 0 to 9 10	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/- to 19/3
Block Tin (cash)	158 12 6
,, (three months)	159 10 0
Copper (cash)	68 2 6
,, (three months)	63 10 0
Spanish Lead (cash)	24 2 6
,, (three months)	23 7 6
Spelter (cash)	31 10 0
,, (three months)	30 15 0
MANCHESTER—	
Copper, Best Selected Ingots	67 10 0
,, Electrolytic	71 0 0
,, Strong Sheets	94 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	25 10 0
,, Foreign	24 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/9½ per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24	10/-
,, 6 p.c. to 8 p.c. ,,	£23 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£23 10 0	8/-
,, Specially Refined ...		
Max. 2 p.c. carbon	£60	26/-
,, 1 p.c. ,,	£70	30/-
,, 0·75 p.c. carbon	£75	37 -
,, carbon free	1/7 per lb.	
Metallic Chromium	5/- per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale unit	5/- per
,, ,, 75 p.c.	23 10 0 scale unit	6/- per
,, Vanadium	18/- per lb.	
,, Molybdenum	6/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	21/6
,, ,, Ell	22/6
,, ,, Splint	22/6 to 24/6
,, ,, Trebles	23/-
,, ,, Doubles	22/-
,, ,, Singles	20/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	21/6
,, ,, Splint	22/6
,, ,, Trebles	23/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/6 to 24/-
Screened Navigation	23/6
Trebles	23/6
Doubles	22/6
Singles	21/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	21/6
Trebles	23/6
Doubles	22/6
Singles	21/-

ENGLAND.

(8) N.W. COAST—	
Steams	30/-
Household	46/8 to 57/6
Coke	33/-
NORTHUMBERLAND—	
Best Steams	24/- to 24/6
Second Steams	23/- to 23/6
Steam Smalls	14/- to 15/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 24/6
Second	21/- to 22/-
Household	25/- to 28/-
Foundry Coke	33/- to 35/-

SHEFFIELD—	Inland.	
S. Yorks. Best Steam Hards	21/- to 22/-	—
Derbyshire Hards	19/- to 20/-	—
Seconds	18/- to 20/-	—
Cobbles	17/- to 19/-	—
Nuts	15/- to 16/-	—
Washed Smalls	10/- to 11/-	—
Best Hard Slacks	12/- to 13/-	—
Seconds ,,	9/- to 10/6	—
Soft Nutty ,,	7/6 to 8/6	—
Pea ,,	7/- to 8/-	—
Small ,,	2/- to 4/6	—
House, Branch	30/- to 33/-	—
,, Best Silkstone	27/6 to 29/-	—
Blast Furnace Coke (Inland and Export)	20/- to 30/-	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	27/6 to 28/6
Second ,,	26/6 to 27/6
Best Dry Large	28/6 to 29/-
Ordinary Dry Large	27/6 to 28/6
Best Black Vein Large	26/- to 26/6
Western Valley ,,	26/- to 26/6
Best Eastern Valley Large	25/- to 26/-
Ordinary ,, ,,	23/6 to 25/-
Best Steam Smalls	17/6 to 18/-
Ordinary ,,	16/6 to 17/6
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	28/- to 29/-
,, ,, Smalls	20/- to 21/-
No. 2 ,, Large	22/6 to 23/6
,, ,, Through	19/6 to 20/6
,, ,, Smalls	15/- to 16/-
Coke (export)	37/6 to 40/-
Patent Fuel	27/- to 30/-
Pitwood (ex ship)	29/- to 31/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	60/- to 62/6
Seconds	55/- to 60/-
Red Vein	52/6 to 55/-
Machine-made Cobbles	72/6 to 75/-
Nuts	72/6 to 75/-
Beans	45/- to 50/-
Peas	24/- to 25/-
Breaker Duff	8/6 to 9/-
Rubbly Culm	15/- to 15/6
Steam Coals:	
Large	25/- to 27/6
Seconds	24/- to 25/-
Smalls	14/6 to 16/-
Cargo Through	19/6 to 22/6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

German Machinery.

UNDER the Wiesbaden agreement Germany was to supply material and machinery on account of reparation for the devastated regions, and although that agreement has been in operation for some months, the total value of orders passed on to Germany has not exceeded three million francs, of which 200,000 francs are for building material and the remainder for machine tools and sterilising plant. This disappointing result, which does not even cover the interest on the amount due for reparation, is attributed partly to the dearth of labour in the devastated areas, where it is difficult to import men even with the offer of high wages, and more especially to the formalities that have to be gone through and to the fear that in ordering material from Germany through official channels it will not always be possible to procure what is needed. An arrangement arrived at subsequently with the German authorities in Berlin gave to persons entitled to goods under the reparation scheme the right to place their orders direct with German firms, and to facilititate matters an association representing their interests has entered into negotiations with Herr Stinnes for centralising orders and supplying all that is needed. Herr Stinnes undertakes to create an organisation for the purpose, the cost being covered by a commission of 6 per cent. on all goods sent to France. As the material and machinery supplied for reconstruction will be paid for by the German Government and credited against the account due for reparations and will be admitted into the country under a low tariff, it is feared that trouble will arise over the openings it may provide for fraudulent practices, against which the French Government is taking stringent measures. French manufacturers naturally look upon the importation of heavy quantities of German goods with considerable disfavour, but they accept it as a disagreeable necessity, the more so because they are not able to do much in the devastated areas themselves. They are, moreover, accorded facilities for purchasing from Germany, under the reparation scheme, any machinery and plant they may require for developing their production. At the same time, it is feared that this importation of German goods under lower tariffs will have the effect of depreciating prices on the French market. The present negotiations are, however, likely to result in improving the commercial relations between the two countries. That, at least, can be inferred from recent statements by the Marquis de Lubersac, who carried out the negotiations with Herr Hugo Stinnes on behalf of the association of persons in the devastated area whose losses are to be made good under the new scheme.

Working Hours.

The heavy deficit in railway working caused by an enormously increased expenditure and by a falling off in efficiency resulting from the eight hours' day, left the Conseil Supérieur des Chemins de Fer with no alternative but to propose that during a period of seven years the railwaymen should be required to work an additional 300 hours a year without extra pay, which meant that the working day would be increased to nine hours for the same wages that are now being received. In this way it was hoped to realise an economy of 428 million francs a year and to prepare the way for a reduction of railway freights, which is regarded as essential to the prosperity of the home industries. The Government was afraid that the proposal was of too drastic a character, and by the Decree which has just been signed, and which will be put into operation almost immediately, the railwaymen will be required to work an additional 300 hours per year, for which, however, they will receive extra payment. The expected saving will be reduced to 300 million francs. This compromise satisfies neither the railwaymen nor the railway companies, the former declaring that the deficit and the falling off in efficiency are due largely to an obsolete equipment, and they further argue that as the total deficit of the six leading companies has declined steadily from 3000 million francs in 1921 to probably less than 1200 million francs during the present year, the time will come when, under proper management, the deficit will be wiped out altogether. On the other hand, the companies affirm that the new Decree will only permit of the number of railwaymen being reduced by 33,000 instead of by 55,000, as would have been possible under the arrangement proposed by the Superior Council. There will still be 67,000 more men employed on the railways than was the case before the eight hours' law came into operation, and this, too, at a time when labour is very scarce in other essential industries. The companies are of the opinion that the drafting of superfluous men into trades where they are needed would do much to overcome the crisis. As things are, they do not believe that the economies effected will be sufficient to allow of any large reduction of railway charges. While the railwaymen will be required to work nine hours a day, a Decree has been signed suppressing the eight hours' day in the merchant marine until such time as it shall be adopted in other countries. Seamen must now be on duty twelve hours. The men's union has been making desperate efforts to prevent the signing of the Decree and now threatens to render it inoperative by means of strikes; but there is a general impression that the union will not take extreme action in face of public opinion.

Direct Process Steel.

The efforts of M. Basset to produce steel direct from the ore in a special rotary furnace have induced a number of other metallurgists to experiment along similar lines. Although considerable sums of money have been spent upon installations for developing the Basset process, and licences have been granted to important firms in France and Belgium, it does not appear as if the results are conclusive, some overlooked trouble having been experienced through the difficulty of lining the furnace to resist the extremely high temperatures. In the opinion of the inventor these troubles will be overcome in time. Meanwhile it is reported that a metallurgist in the Hautes-Pyrénées, M. Toussaint Levoz, has obtained remarkable results in the way of producing steel direct from the ore in an electric furnace. The product is a manganese steel possessing a high degree of ductility.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

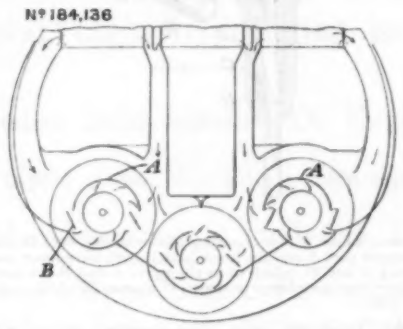
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

184,136. November 14th, 1921.—IMPROVEMENTS RELATING TO OIL-FIRED FURNACE FRONTS, John Reid, of 4, Lloyd's-avenue, E.C.

The object of this invention is to promote a smooth and even flow of air to the zone of the burner flame. The body of the furnace front may be built up of front and back plates, spaced apart by intermediate curved walls A, having valves B arranged

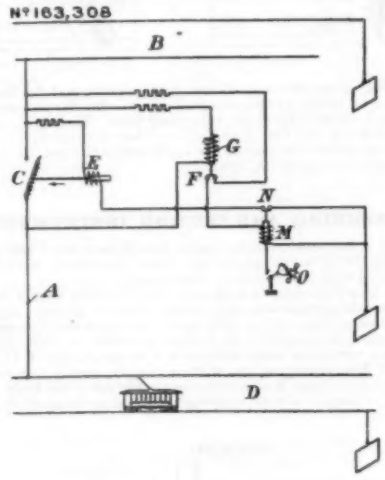


as shown, and enclosing guide blades extending between the front and back walls. With this arrangement the air is given an easy regular whirling motion through the furnace front, and is evenly distributed around the burner tube.—*August 10th*, 1922.

TRANSMISSION OF POWER.

163,308. May 12th, 1921.—IMPROVED APPARATUS FOR PROTECTING ELECTRIC SUPPLY CIRCUITS COMPRISING AERIAL LINES, Brown, Boveri et Cie., of Baden, Switzerland.

In the installation, shown in the diagram, the feed line A is to be switched in automatically when the bus-bars B are carrying current. If, during a given period of time, no fault occurs in the portion D of the supply circuit that is to be switched in, the maximum current switch C is brought into the switching-in position by means of the switching-in magnet E. If, however, there is a short-circuit in the supply circuit portion D, the magnet winding G of the relay F, which is in parallel with the contacts of the switch C, will receive current and will open the relay

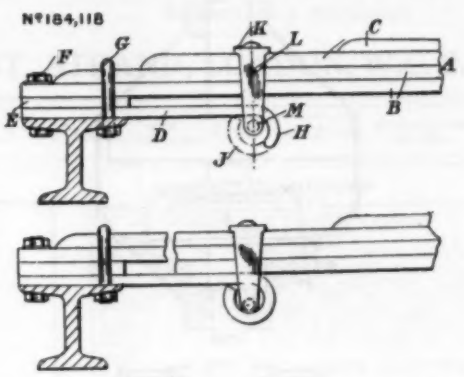


contact F. By this means current is cut off from the magnet winding M of the time relay N O, which instantly opens the contact N, so that the switching-in magnet E now receives no current and the switch C remains open until the short-circuit has ceased to exist. The relay G then closes its contact F, so that the winding M of the time relay receives current. The contact N is, however, not closed at first, but only after the lapse of a period of time determined by the setting of the time mechanism O. Should a further short-circuit occur during this period of time, the contact F will open, and the time mechanism will instantly return into its initial position, even before it has closed the contact N and energised the switching-in magnet E. —*August 10th*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

184,118. December 17th, 1921.—IMPROVEMENTS IN THE SPRING SUSPENSION OF VEHICLES, The Standard Motor Company and Reginald Walter Maudslay, both of Cash's-lane, Coventry.

The axle is attached to the ends of cantilever or similar springs, and a safety device is provided upon the axle to support the vehicle if the spring breaks near its junction with the axle. The spring A comprises two main leaves B, with subsidiary leaves C. The main leaves are secured in the usual manner to the axle, but between this and the spring is interposed the safety device D, which constitutes the supporting member, spaced apart from the spring by a packing piece E, the securing members F and G, comprising respectively a straight bolt extending through the spring and the safety device and distance piece, and a U-shaped bolt which embraces these parts. The safety device D is composed of an arm extending towards the foot of the spring. The free end of this arm is bent round, as shown at H, or if desired the bent part is extended as shown by the dotted lines J to form a complete eye. Attached to the subsidiary leaf C of the spring is a U-shaped bracket K, forming a yoke member, the limbs of which depend on each side of the spring A with clearance from the sides. The free ends of the limbs L are situated with reference to the bent portion H J of the safety device, so that a bolt coupling them together extends

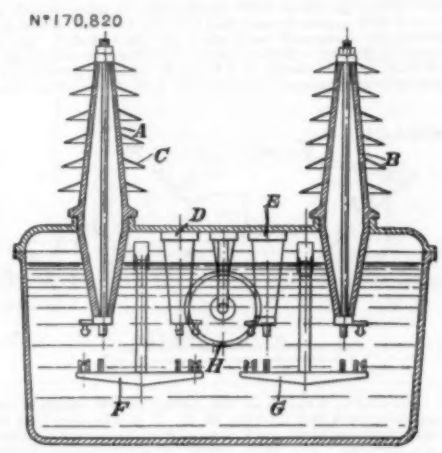


through this bent portion with freedom in all directions, the amount of the clearance being such as to ensure that the normal changes of flexure of the spring under load and road conditions will not cause the pin M to come into contact with the safety device. The lower illustration shows the effect of a fracture in the spring.—*August 10th*, 1922.

SWITCHGEAR.

170,820. October 29th, 1921.—IMPROVEMENTS IN ELECTRIC SWITCHES. La Metallurgique Electrique, of 14, Rue Taitbout, Paris, France.

The lead-in wires pass through two double cones A and B of insulating material, provided with metal fins C, which distribute the potential, and in the case of rain prevent the surface of the insulator becoming wet. At the lower end of the insulators

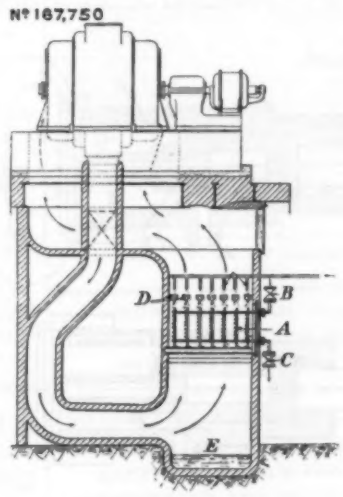


there are fixed contacts, and another set of fixed contacts is also carried on insulators D and E. Movable bars F and G serve for closing the circuit, and the connection between the contacts on the insulators D and E is made by means of the primary winding H of a transformer, which is placed in the oil tank, as shown.—*July 28th*, 1922.

DYNAMOS AND MOTORS.

167,750. August 11th, 1920.—AIR SCRUBBING AND COOLING DEVICE FOR ALTERNATORS, Marius Léon Pourcel, of 38, Rue du Louvre, Paris.

The cooling scrubber constructed in accordance with this invention consists of a set of tubes A placed in a casing, and water may pass through the tubes by way of the valves B and C.

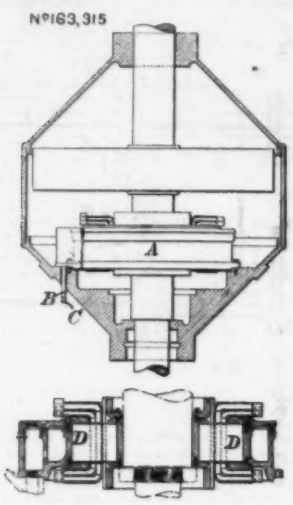


Above the tubes there are troughs D, which distribute the water over each row of tubes. The water sprinkled over the tubes and also that within the tubes falls into the trough E, and may be used for feeding the boilers.—*August 10th*, 1922.

163,315. May 17th, 1922.—IMPROVED COOLING ARRANGEMENTS FOR DYNAMO-ELECTRIC MACHINES, *The Metropolitan-Vickers Electrical Company, of 4, Central-buildings, Westminster.*

This specification describes a system of cooling electric motors

which operate in a vacuum, such, for example, as a motor driving a gyroscope, as shown in the illustration. Cooling water is circulated round the stator A by means of inlet and outlet

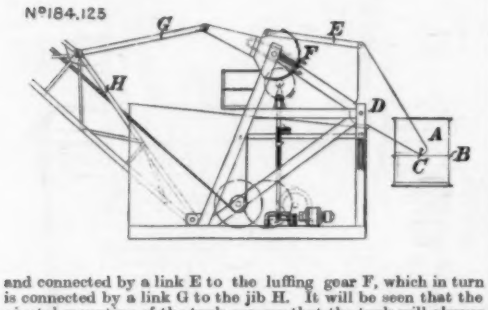


pipes B and C. The frame of the motor is provided with an annular chamber D through which the cooling fluid passes.—*August 10th*, 1922.

CRANES AND CONVEYORS.

184,125. February 4th, 1922.—IMPROVEMENTS IN OR RELATING TO CRANES, Babcock and Wilcox, Limited, and Frederick William Hollick, both of Oriel House, 30, Farringdon-street, E.C.

This invention relates more particularly to cranes which are provided with means for ensuring that the load will travel in a substantially horizontal path when the jib is luffed. In the drawing, A denotes a ballast tank, which may be composed of mild steel, and be carried in a frame B, which is pivoted at C to a cantilever structure D, fulcrumed on the frame of the crane

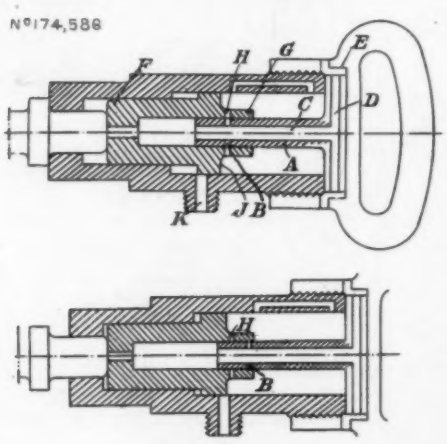


and connected by a link E to the luffing gear F, which in turn is connected by a link G to the jib H. It will be seen that the pivotal mounting of the tank ensures that the tank will always remain upright. The tank serves to accommodate ballast consisting, for example, of stones or other material available at the site, the ballast, together with the tank, constituting the balance weight as in certain prior forms of balance weights for cranes.—*August 10th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

174,586. January 4th, 1922.—IMPROVEMENTS IN OR RELATING TO PNEUMATIC HAMMERS, Armand Bailly, of 46, Quai Henri IV., Paris.

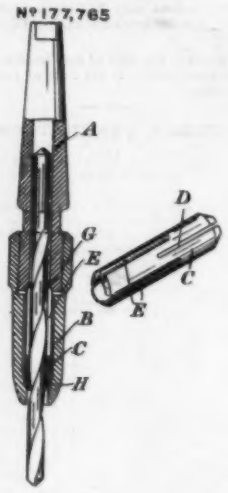
The exhaust tube A is provided with openings B, which are intended to allow the air which has done its work in the cylinder to escape into the atmosphere through the conduits C D E. The piston F is provided with an extension G with openings H. When the piston arrives at the end of the left-hand stroke, the air which has done its work escapes through the openings H B C D and E. But if for some reason the tool is moved forward, the piston will continue to move to the left, as shown



in the lower illustration. The openings H and B will then be closed again, thus shutting off any communication with the outside, and on the face J of the piston then uncovering the opening K, the compressed air in the conduit will pass into the cylinder and fill it and exercise its pressure on the face J of the piston. It will be seen that the result of a movement of the tool is an instantaneous stoppage of the piston, without any direct passage of the compressed air into the atmosphere, which generally takes place in apparatus as hitherto constructed.—*August 10th*, 1922.

177,765. Jan. 13th, 1922.—PROTECTING DEVICE FOR DRILLS, Johann Kruschitzki, of No. 26, Gellhornstrasse, Breslau, Silesia, Germany.

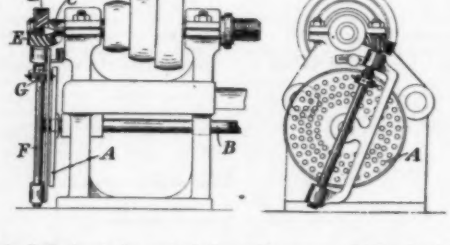
The object of this invention is to avoid twist drills breaking on account of a considerable portion of the drill projecting beyond the chuck. The improved form of protecting sleeve consists of two tubular parts A and B, which are screwed



together, whilst C is a clamping sleeve having slits D and E. The upper part A and the lower part B both have inner conical surfaces G and H, which when the parts A and B are screwed together grip the clamping sleeve C against the drill.—*August 10th*, 1922.

183,887. March 4th, 1921.—IMPROVEMENTS IN AND RELATING TO LATHES, *Edward Charles Robert Marks, of 57 and 58, Lincoln's Inn-fields.*

The object of this invention is to provide a simple scheme for giving a lathe a large number of speed variations. A disc A is mounted on the guide screw B driving the slide. On the cone pulley spindle C a screw wheel D is fixed which meshes with a removable screw wheel E. The shaft F is journalled in a frame, which together with the shaft F and the screw wheel E can be

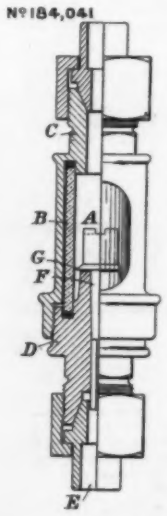


swivelled about the end of the guide screw, and be fixed in position by means of the clamping screw. On the periphery of the small wheel G there are extending pins. These pins engage in the holes of the disc A and the number of revolutions varies according to the distance of the small wheel G from the centre of the disc.—*August 4th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

184,041. July 20th, 1921.—IMPROVED MEANS FOR INDICATING THE FLOW OF LIQUIDS, Sir John Dewrance, K.B.E., of 165, Great Dover-street, Southwark.

This invention relates to means for indicating that a flow of liquid is taking place through a given vessel or passage, and also for indicating the rate of such flow. The apparatus consists of a chamber A composed of a glass cylinder or sight tube B arranged vertically and mounted in a bi-part holder C D. The oil inlet E is at the bottom of the chamber, and is surmounted by a weighted body F adapted to cover the inlet, the body being formed or furnished with a laterally extending flange G or other

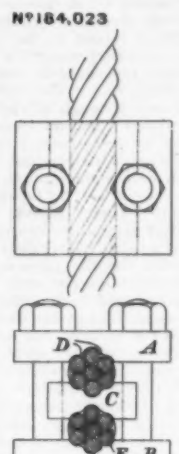


pointer. As oil flows through the chamber A, the fact that such flow is taking place becomes apparent by reason of the weighted body F rising from its seat over the upper extremity of the inlet orifice, and as the rate of flow increases the rate of increase is indicated by the higher position of the laterally extending flange or pointer G in relation to a calibrated scale marked on the surface of the enclosing cylinder or sight tube B or upon the holder. An alternative arrangement is described for use in connection with a forced feed lubricating system.—*August 10th*, 1922.

MISCELLANEOUS.

184,023. July 6th, 1921.—IMPROVED CLIP FOR WIRE ROPES, James O'Neal, of 17, East Princes-street, Rothesay, Bute.

The clip shown comprises the usual jaw-forming plates A B connected by bolts and a jaw-forming distance piece C interposed between the plates. Each jaw surface is formed by a



groove D, adapted partly to encircle the rope to be clipped, and formed with helical channels E corresponding to the helically laid strands of the rope.—*August 10th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

SATURDAY, SEPTEMBER 16TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Luton. London members will leave St. Pancras by the 9.25 a.m. train.

TUESDAY TO FRIDAY, SEPTEMBER 19TH TO 22ND.

THE INSTITUTE OF METALS.—Swansea. Annual autumn meeting. For programme, see page 152.

FRIDAY, OCTOBER 6TH.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Connaught Hall, Newcastle. For the purpose of inaugurating a branch in the Newcastle district. Paper, "The Necessity for Scientific Costing," by Mr. S. Hunter. Tickets may be obtained from the secretary at 38, Grosvenor-gardens, S.W. 1. 7.30 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. First meeting of winter session. Paper, "Engineering in Bacon Factories," by Mr. W. A. Tookey, M.I. Mech. E. 7.30 p.m.

LANTERN SLIDES.—The National Gas Engine Company, Limited, Ashton-under-Lyne, informs us that it is willing to render assistance during the coming winter to lecturers who wish to deal with internal combustion engines or suction gas plants. The company has a large selection of lantern slides, views of its works, installations of all sizes, sectional views, &c., which it is prepared to lend free of charge. A descriptive list of the slides will be forwarded on request. The company is also willing to give assistance in the preparation of lectures as far as its own manufactures are concerned.

MR. GEORGE RICHARDS.—We regret to learn that Mr. George Richards, formerly of George Richards, Limited, Broadheath, Manchester, is now disabled owing to paralysis and quite incapable of any further work. He suffered serious financial loss during the war and is now dependent on the kindness of his friends for support. Endeavours are being made by some of these to raise a fund to assist him and—at his desire—to provide for the maintenance and education of his youngest child, a boy of thirteen, until he is able to support himself. Subscriptions will be gratefully received by Mr. A. J. Munro, 103, Cornwall-road, South Tottenham, N. 15, or Mr. L. N. Burt, 7, Outer Temple, W.C. 2. We feel sure that those of our readers who are acquainted with Mr. Richards' work in the past and know of his genius in the design of machine tools will not hesitate to help him in the adversity that has overtaken him.

INDUSTRIAL WELFARE SOCIETY.—The third annual lecture conference for welfare supervisors, organised by the Industrial Welfare Society, will be held at Balliol College, Oxford, from to-day to September 20th. This year the conference is open to both men and women, special arrangements having been made for the women delegates at Lady Margaret Hall. The session will be opened this evening by Mr. J. W. Pratt, Parliamentary Under-Secretary for Scotland. The programme, which is of a very practical nature, will deal with such subjects as "Welfare Under the Whitley Principle," "The Employment Department: Its Functions and *Personnel*," "Health, First Aid, Safety." On Sunday forenoon Mr. Frank Hodges, J.P., secretary of the Miners' Federation of Great Britain, will give an address on "Health and Welfare in the Mining Industry." Dr. H. M. Vernon, of the Industrial Fatigue Research Board, will speak on "Record Keeping and Statistics." Other lectures will be "Canteens," by Mr. Arthur F. Agar, and "Superannuation and Pension Schemes," by Mr. J. H. Robertson. In addition there will be a series of short practical papers by supervisors, sectional meetings, and a special session for women. All inquiries regarding the conference should be addressed to the Industrial Welfare Society, 51, Palace-street, Westminster, S.W. 1.